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(54) **ROD CONTOURING APPARATUS FOR PERCUTANEOUS PEDICLE SCREW EXTENSION**

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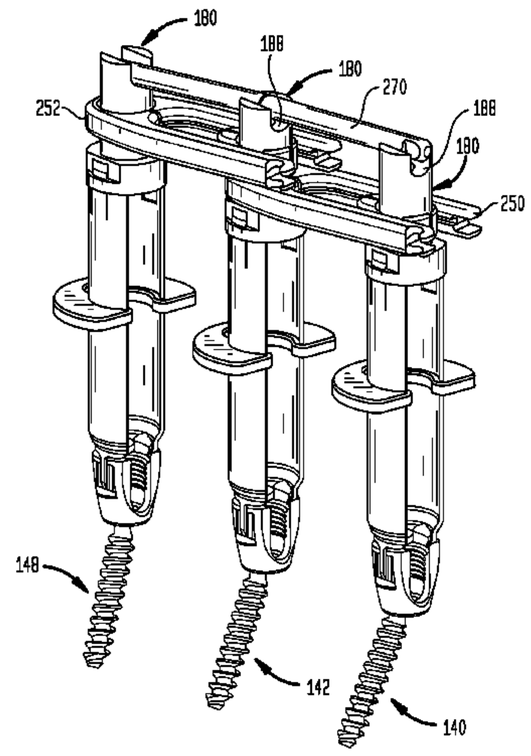
(57) **ABSTRACT**

Anatomic points within the body are projected outside the body through the use of extenders (**180**, **182**, **188**). The projected points may then be used for measurement, or to facilitate the selection or configuration of an implant that is positioned proximate the anatomic points using a slotted cannula (**143**). Such an implant may be a rod (**270**) for a posterior spinal fusion system. Pedicle screws (**140**, **142**, **148**) may be implanted into pedicles of the spine, and may then serve as anchors for the extenders. The extenders (**180**, **182**, **188**) may have rod interfaces (**214**, **216**, **218**) that receive the rod (**270**) in a manner that mimics the geometry of the pedicle screws (**140**, **142**, **148**) so that the selected or configured contoured rod (**270**) will properly fit into engagement with the pedicle screws (**140**, **142**, **148**).

17 Claims, 19 Drawing Sheets



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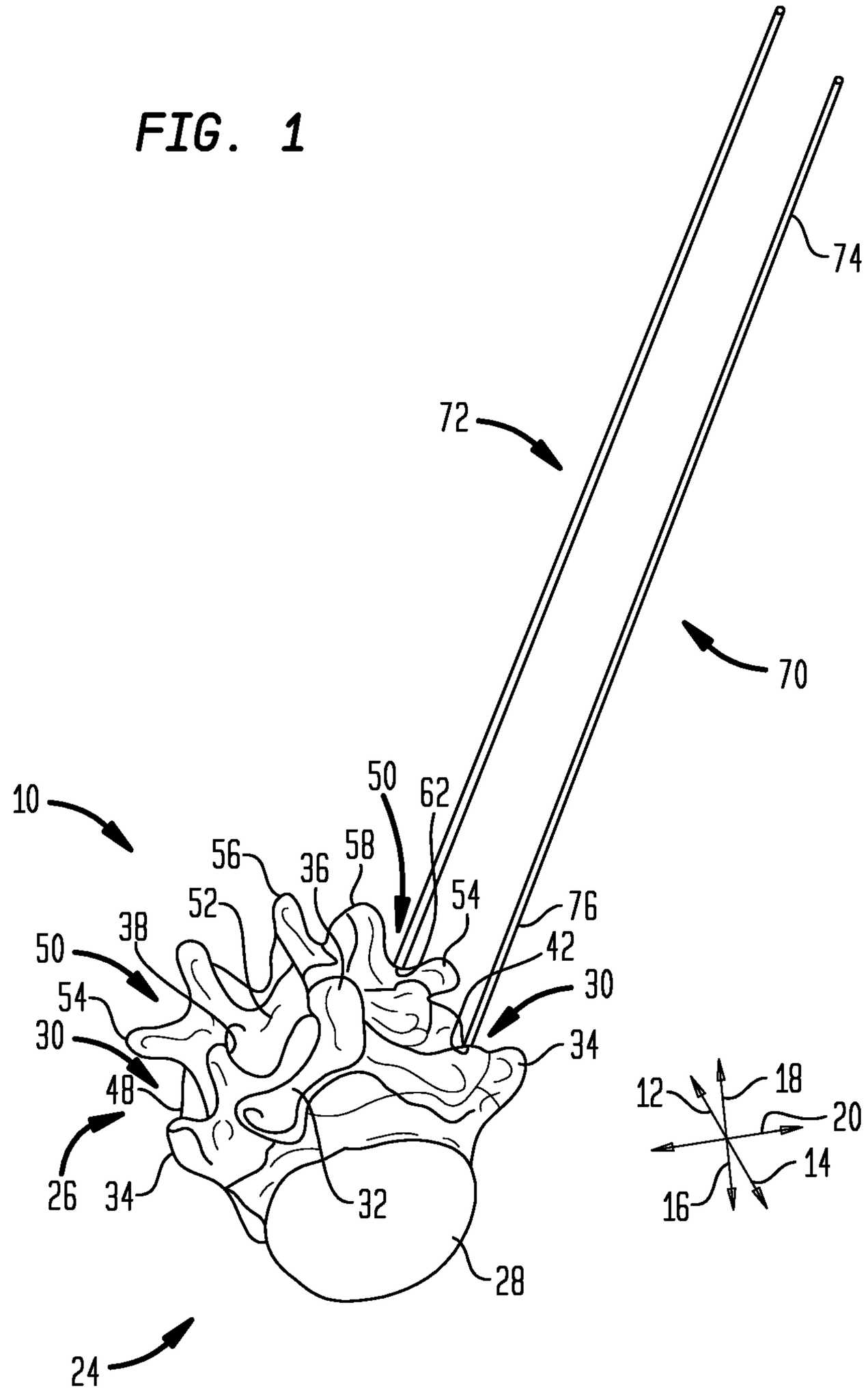
Kambin, Minimally Invasive Techniques in Spinal Surgery Current Practice, Neurosurgical Focus, wwwspineuniversecom, 16 pages, printed Aug. 24, 2005.

* cited by examiner

FIG. 1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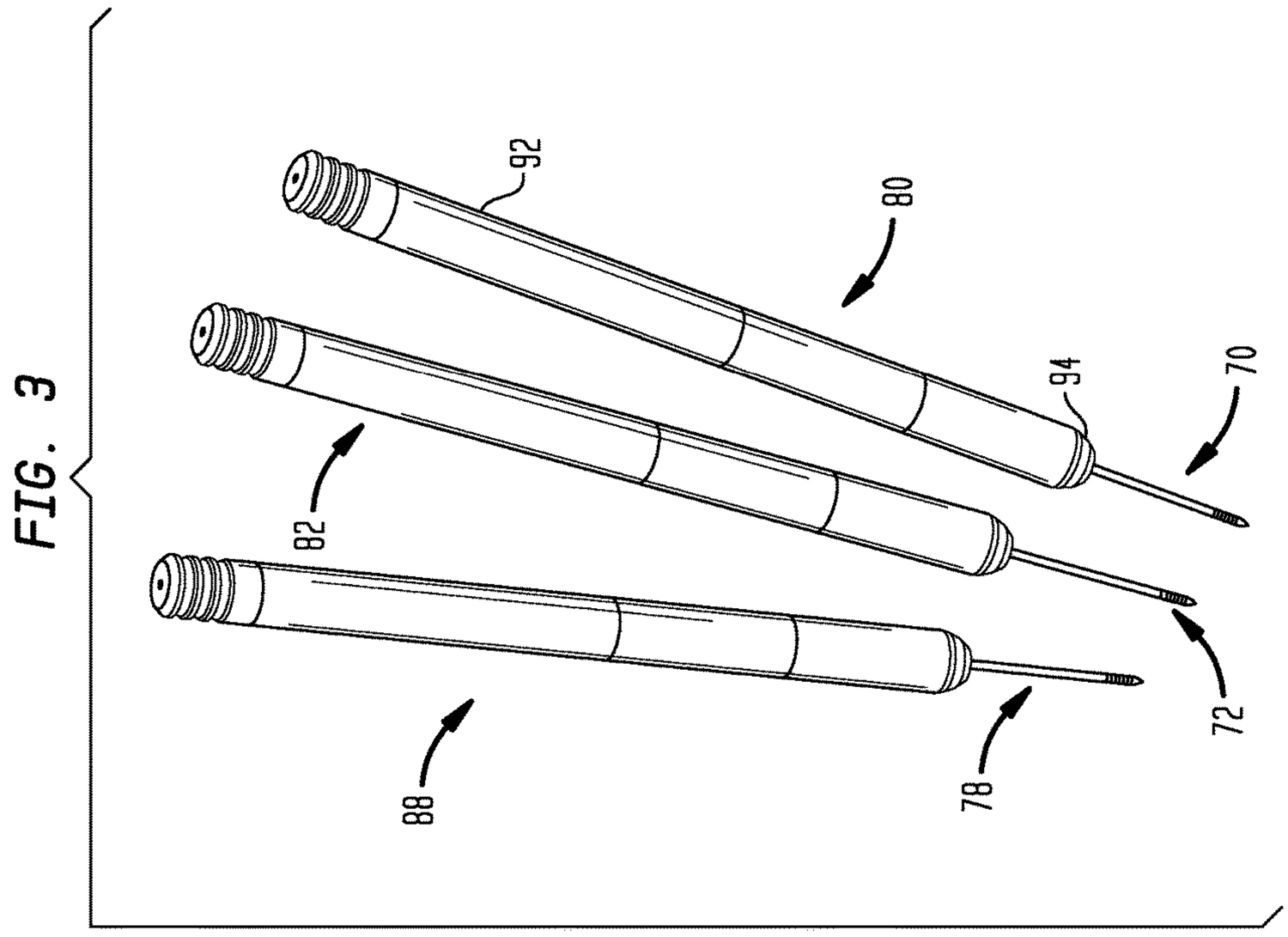

FIG. 3

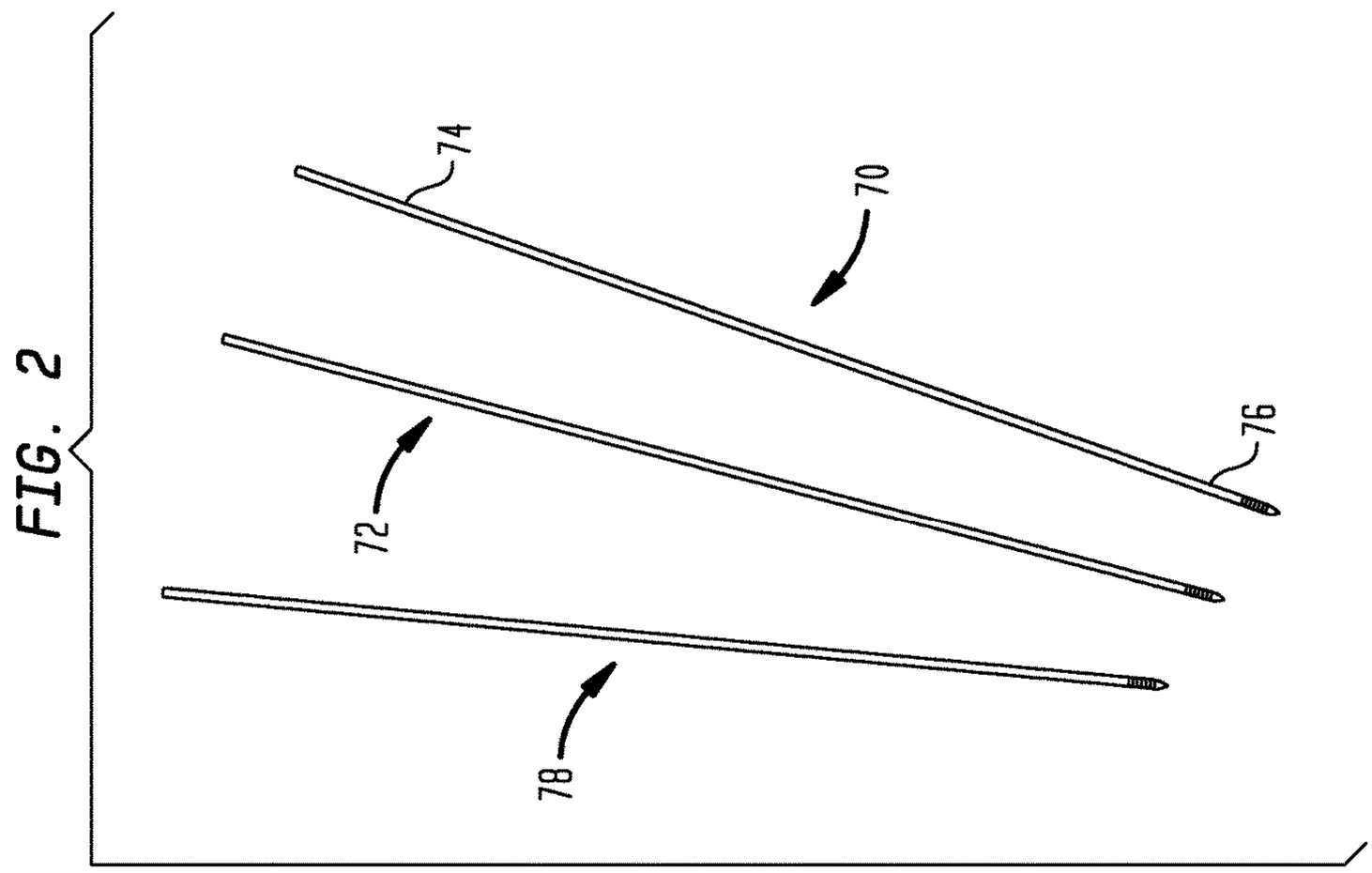

FIG. 2

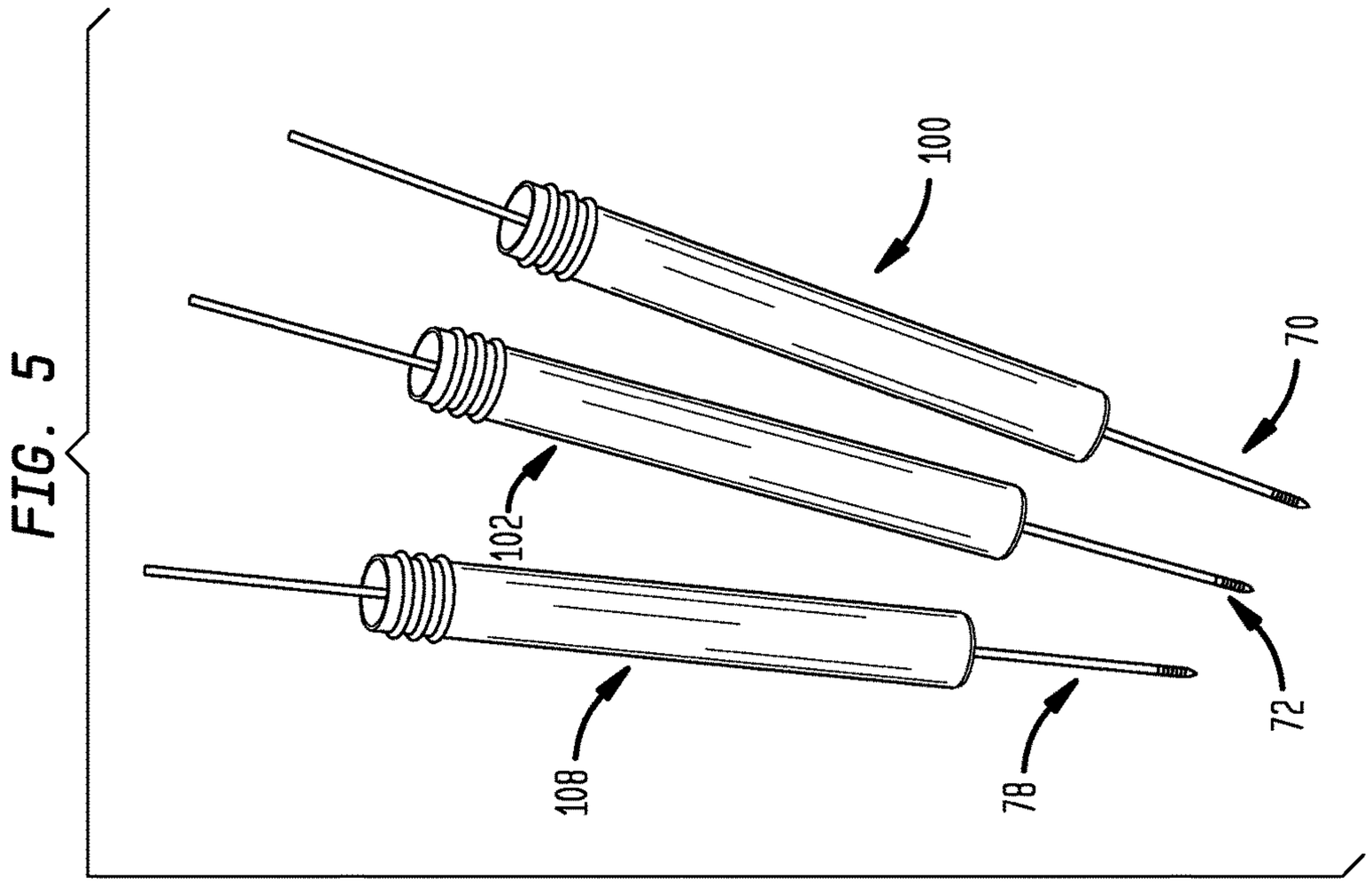
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FIG. 5

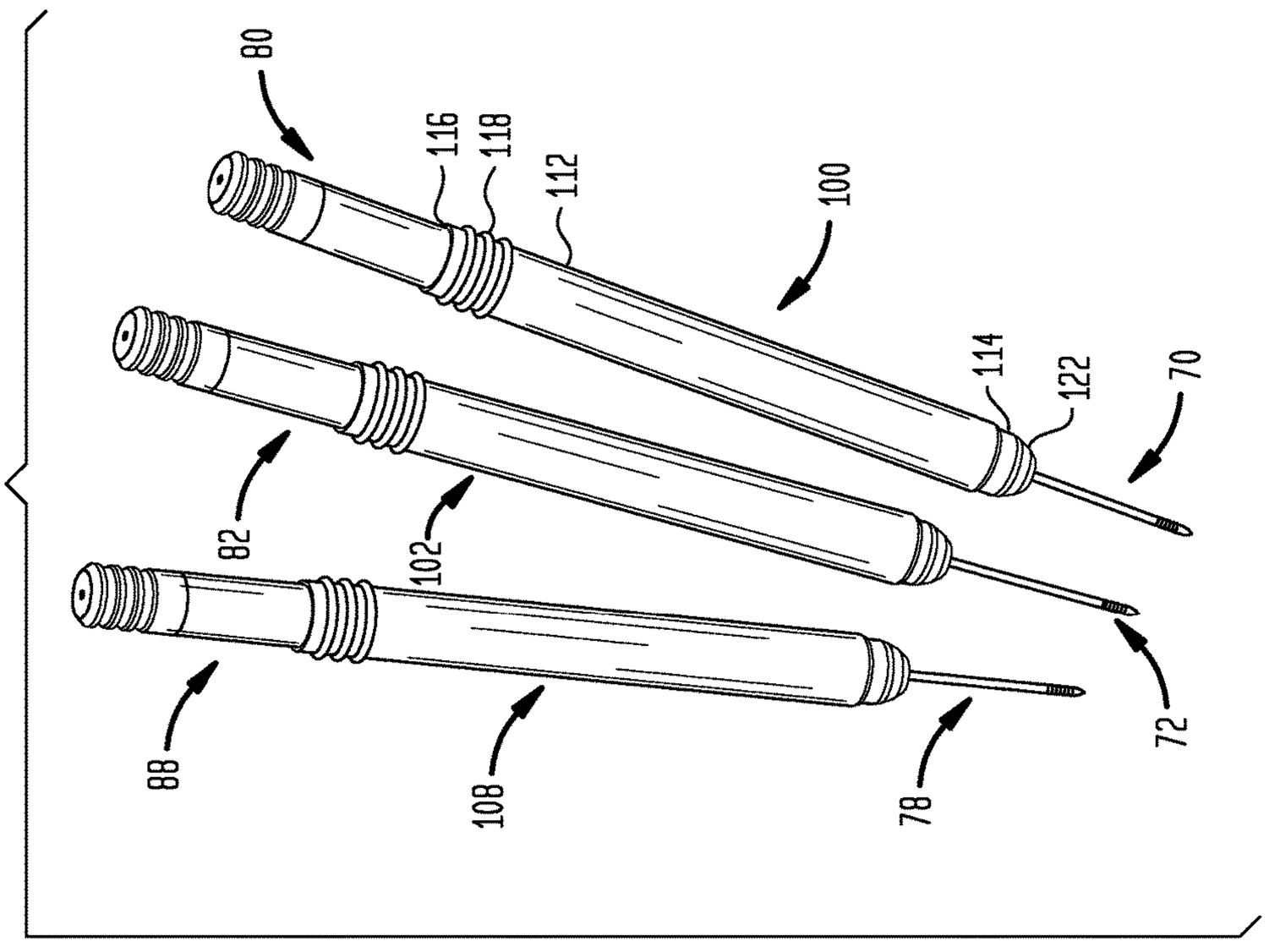
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FIG. 4

FIG. 6

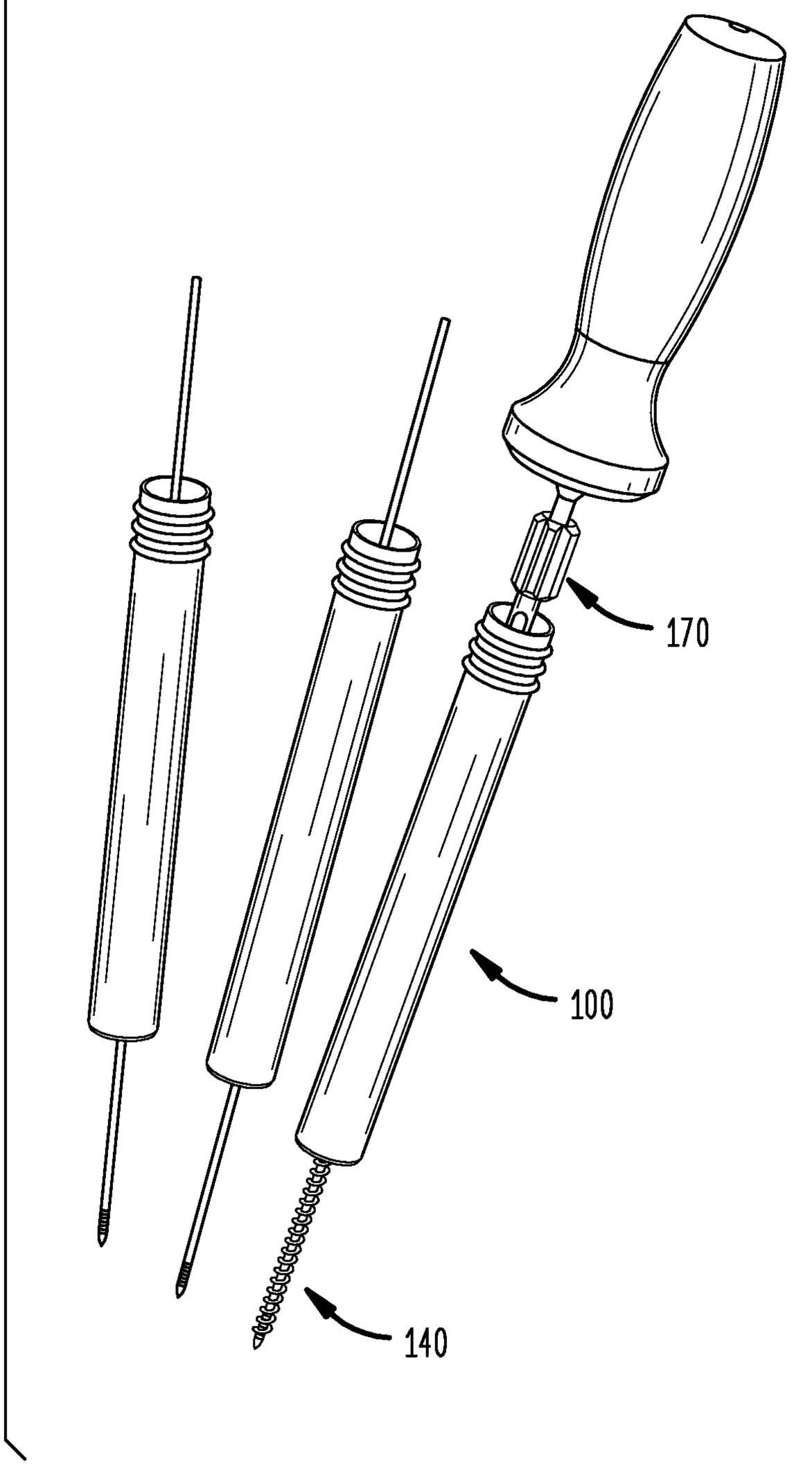

FIG. 7

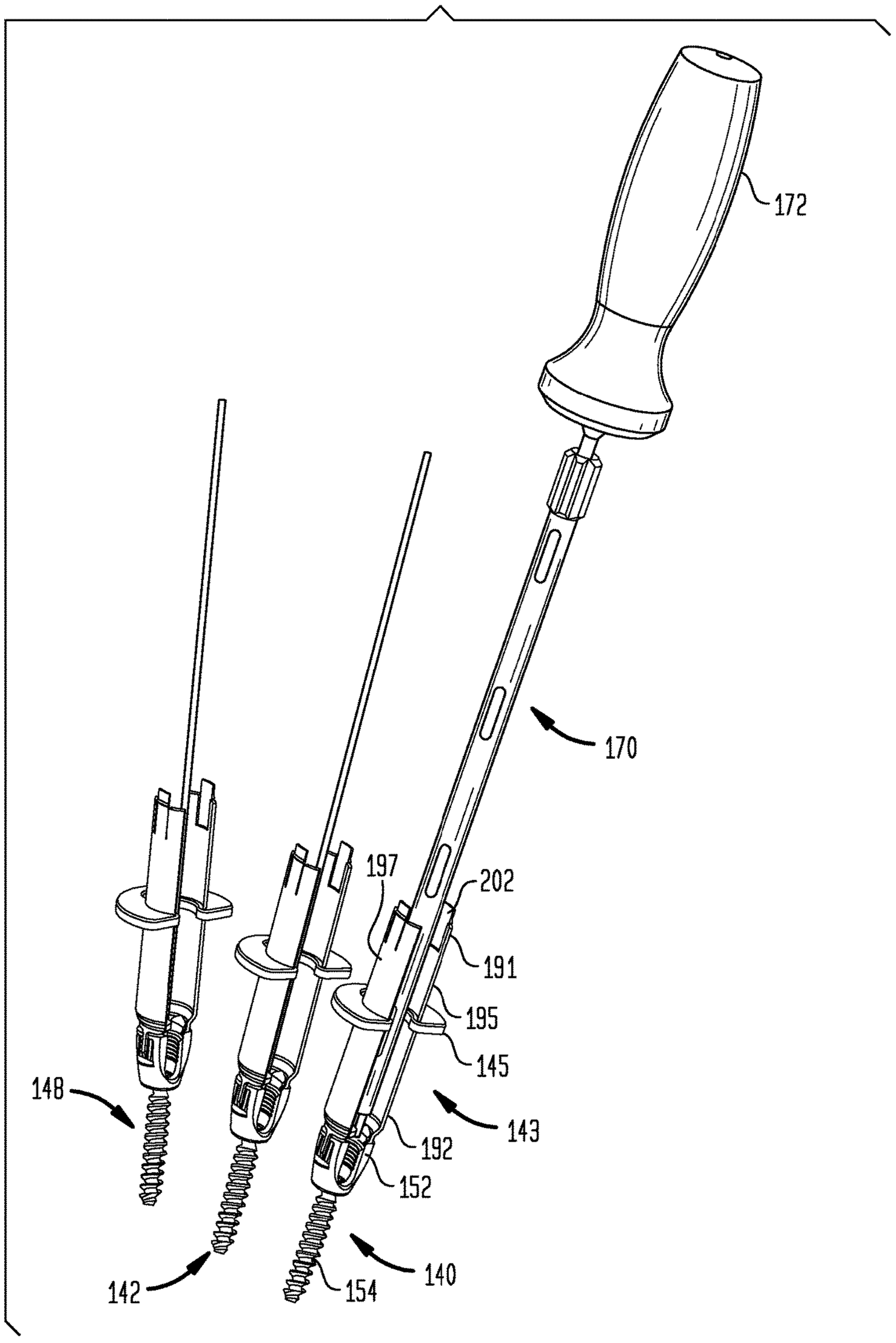

FIG. 7A

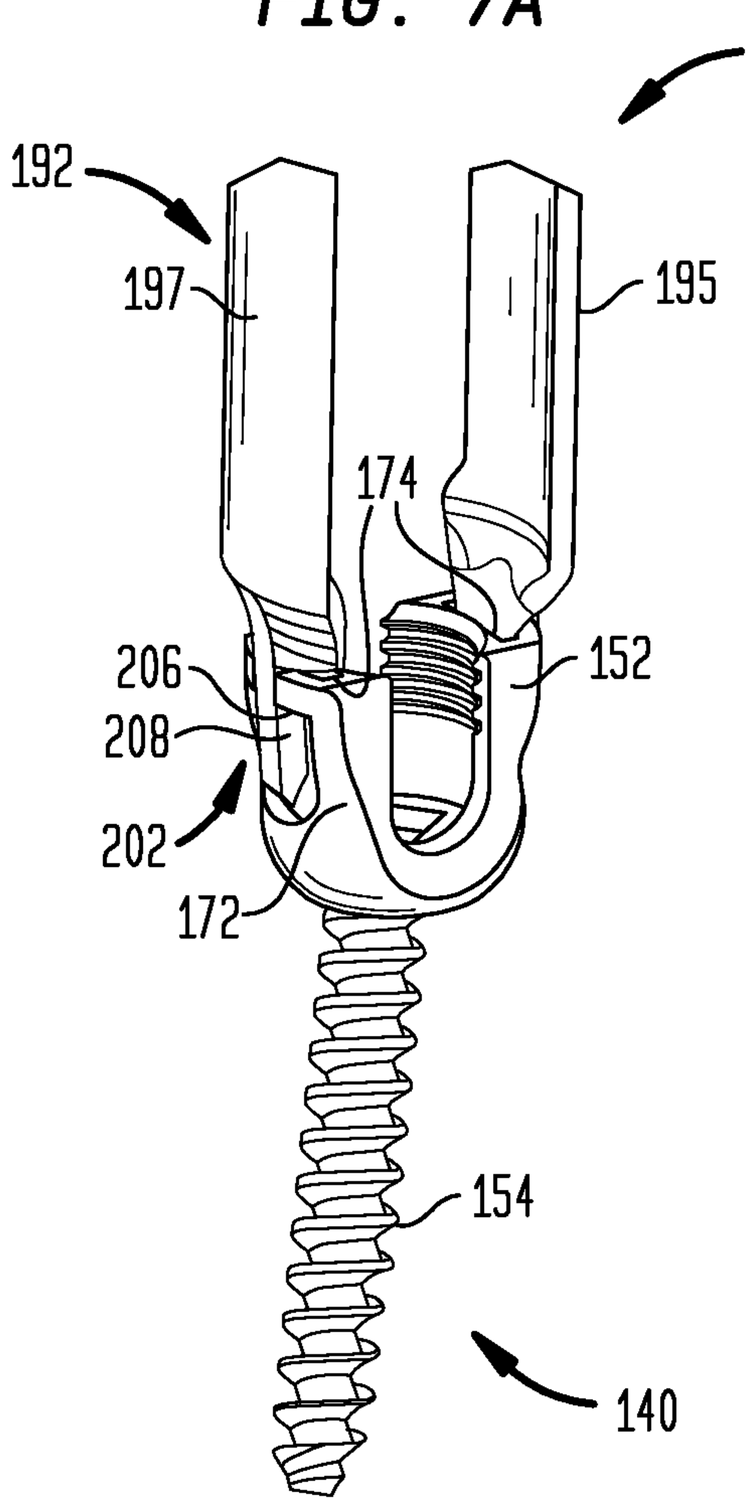

FIG. 8

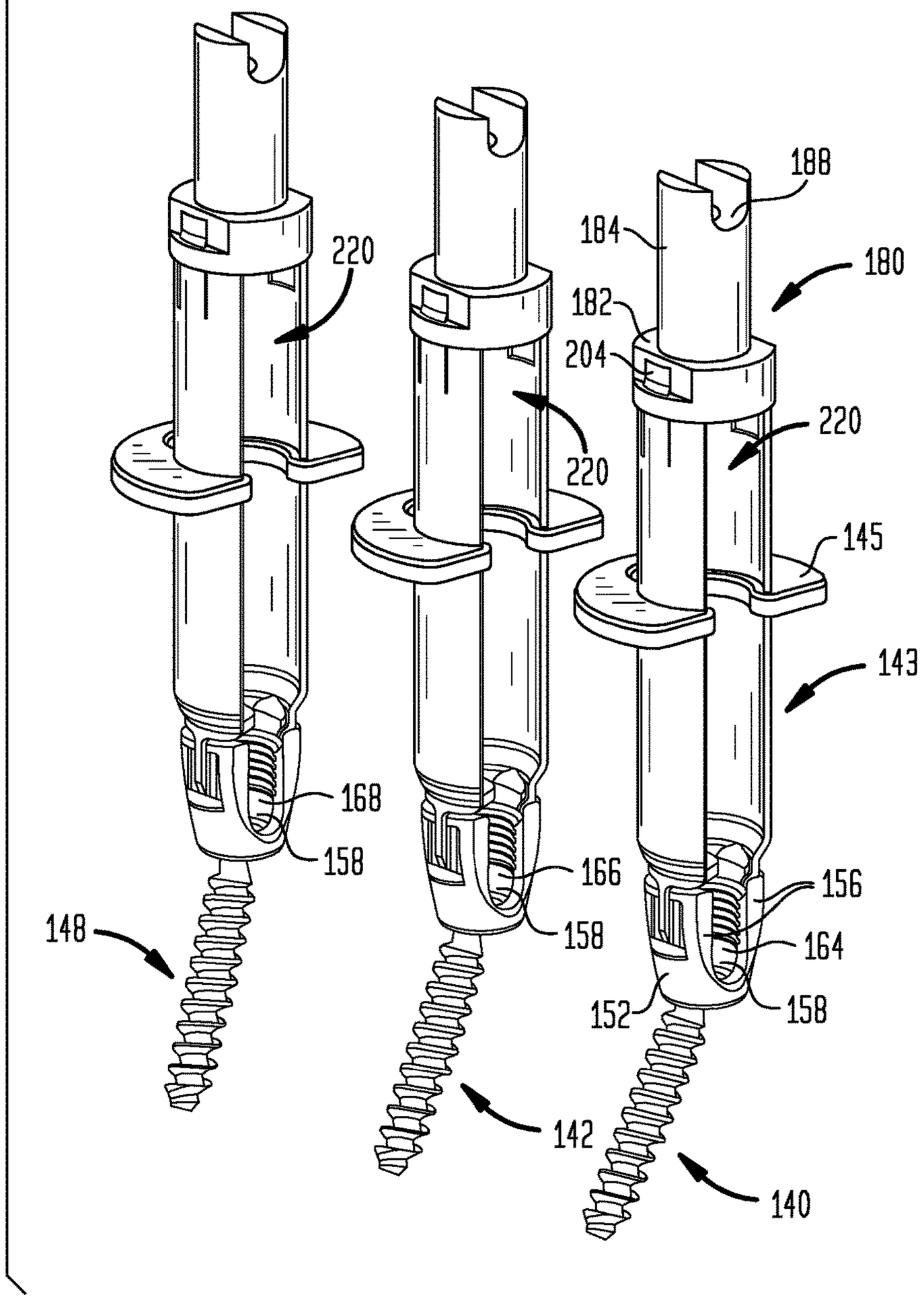
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FIG. 9

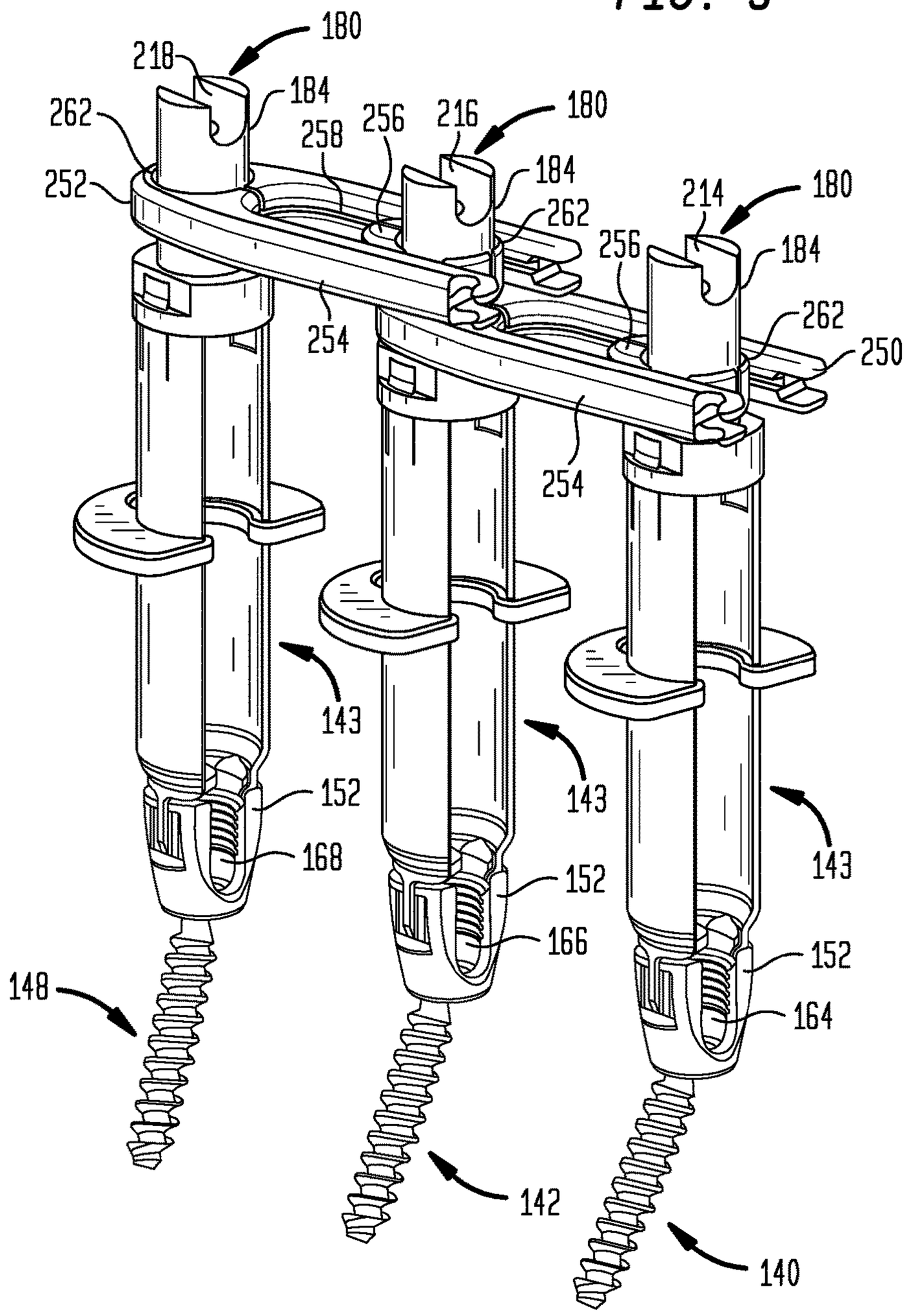
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FIG. 10

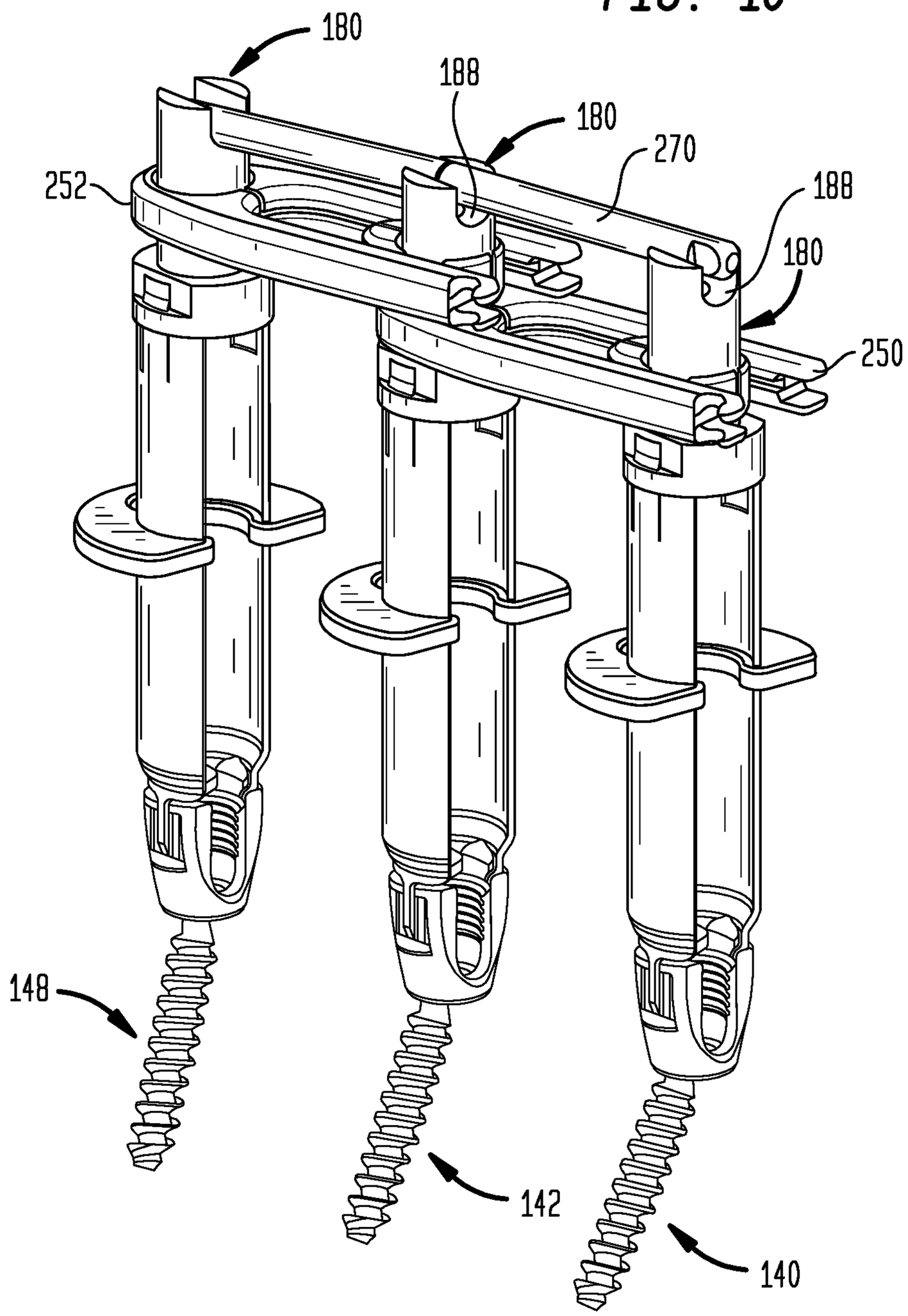


FIG. 11

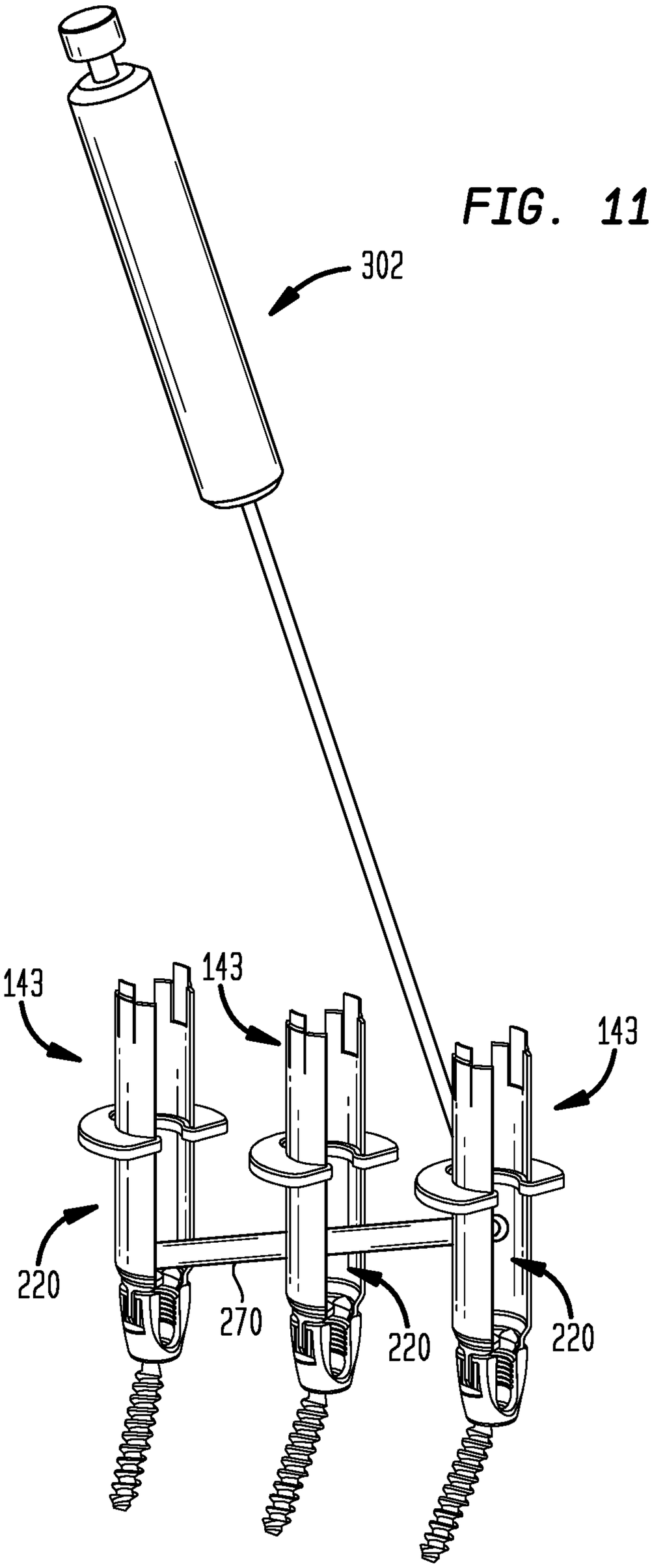


FIG. 12

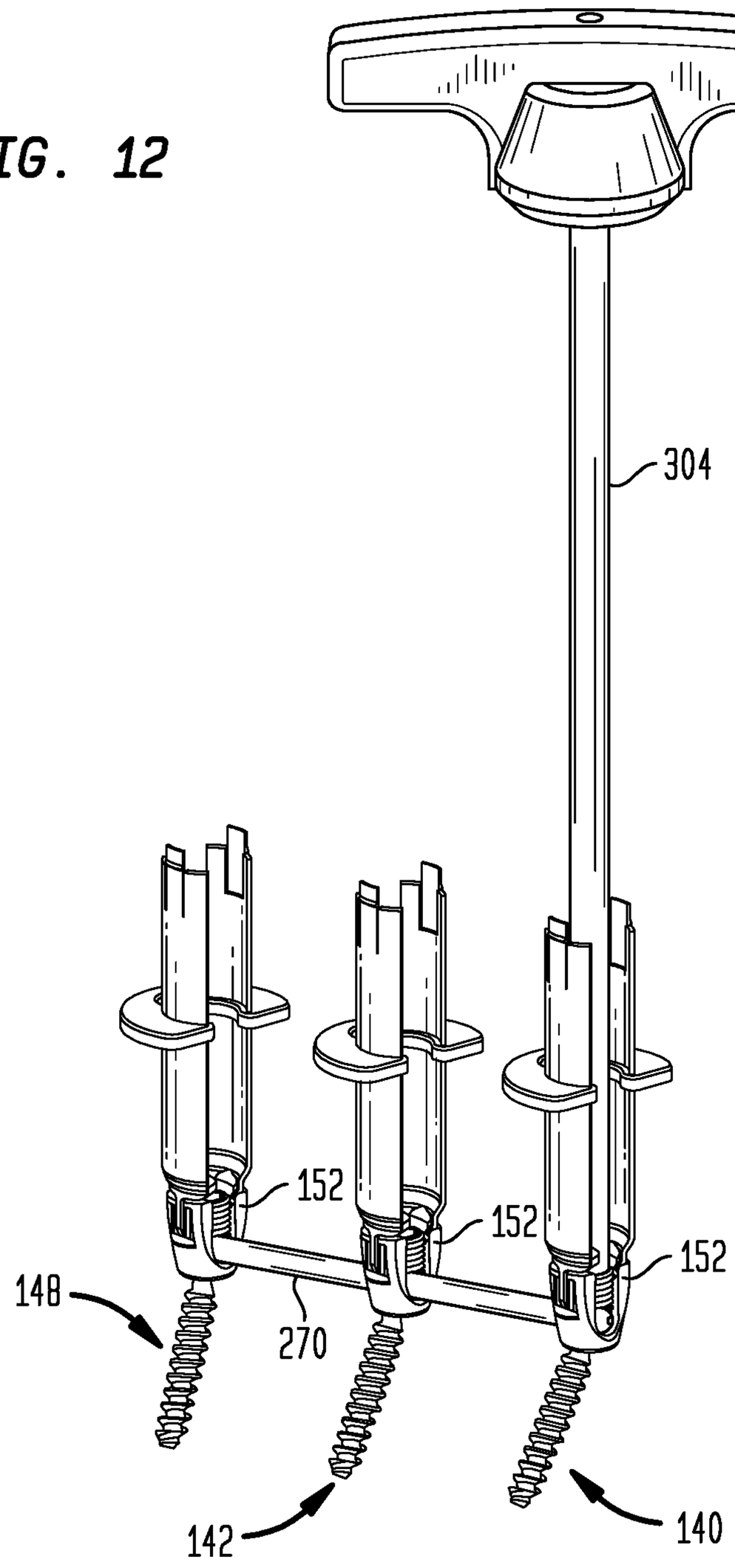


FIG. 13

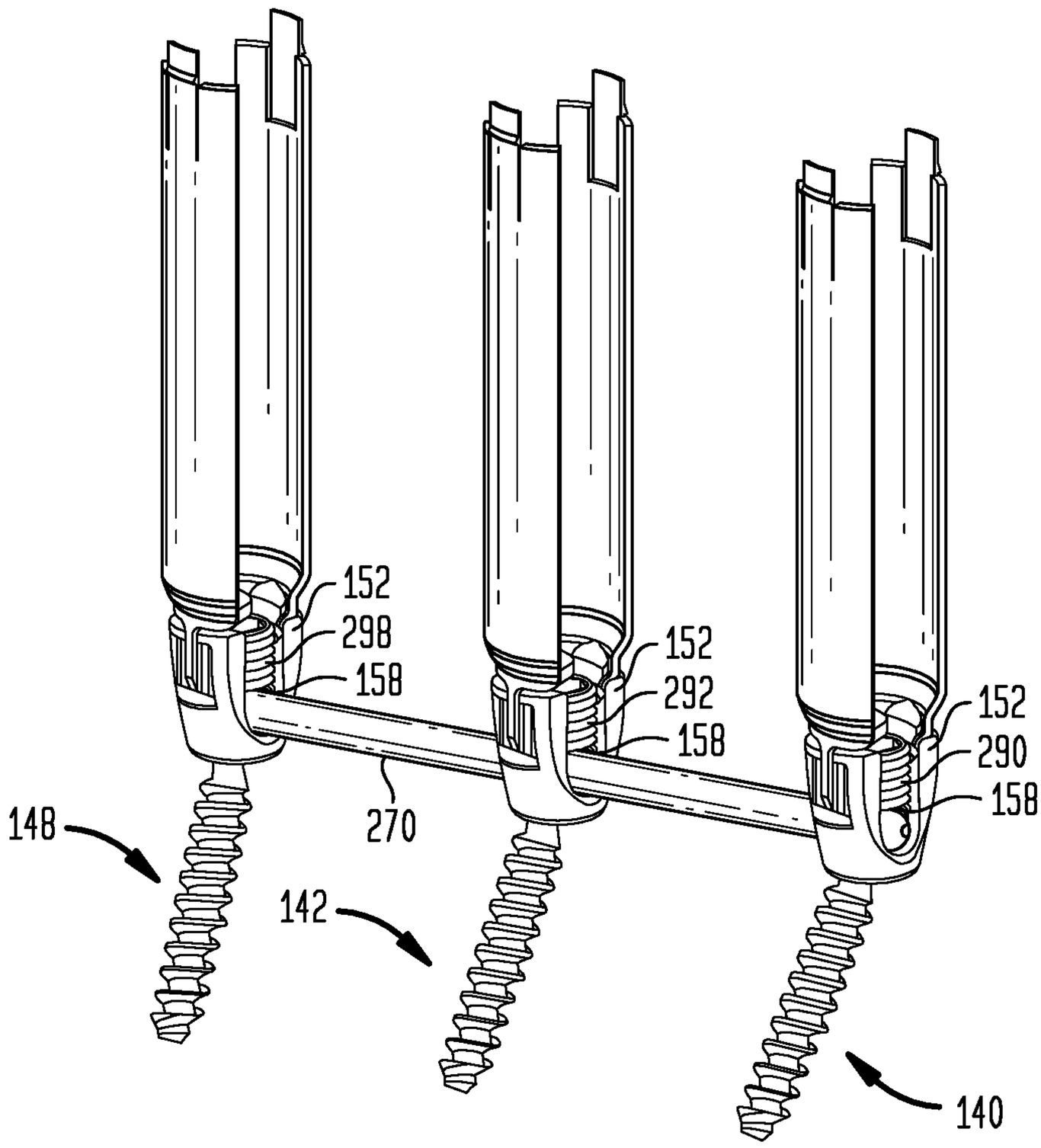


FIG. 14

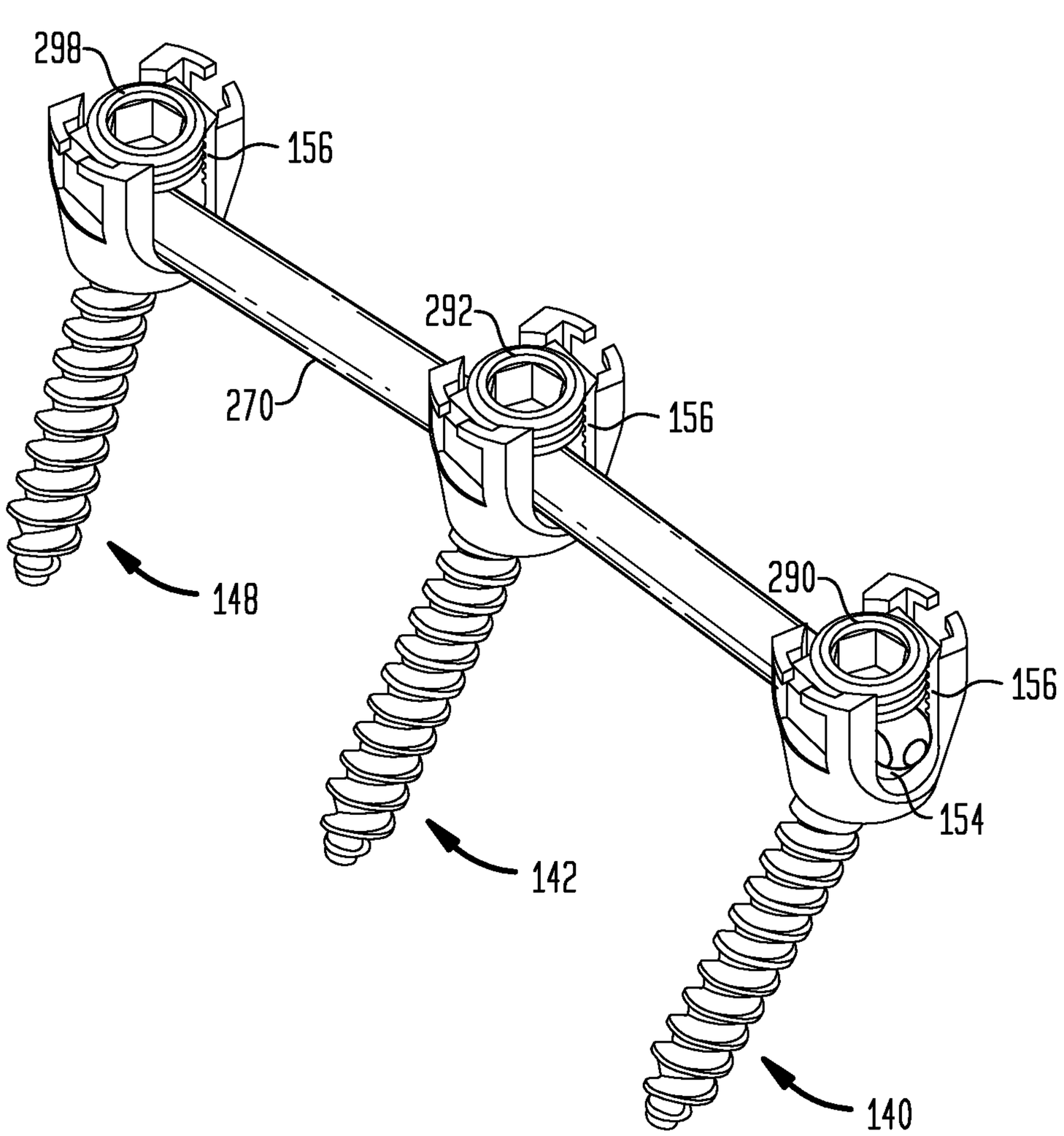


FIG. 15

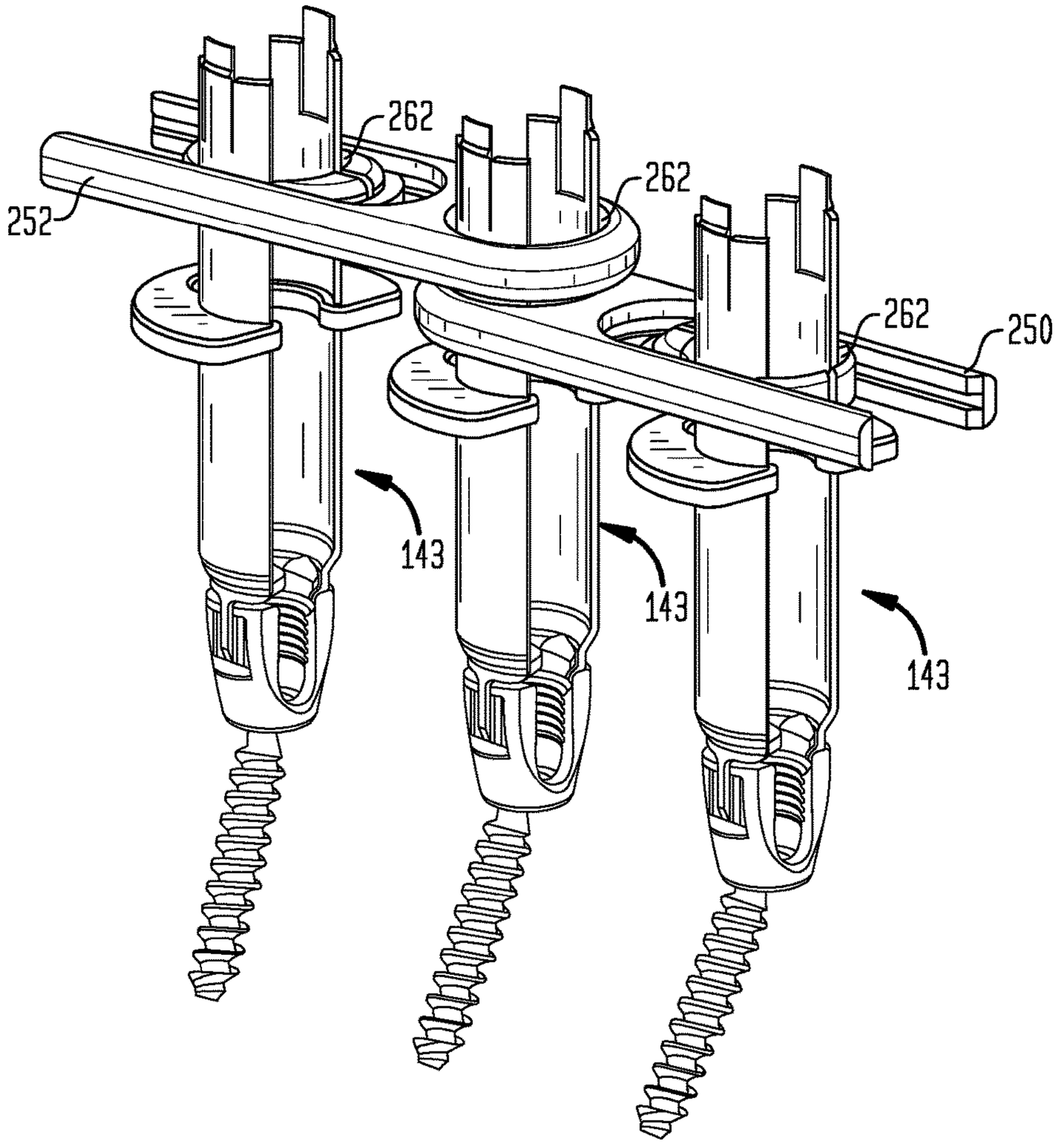


FIG. 16

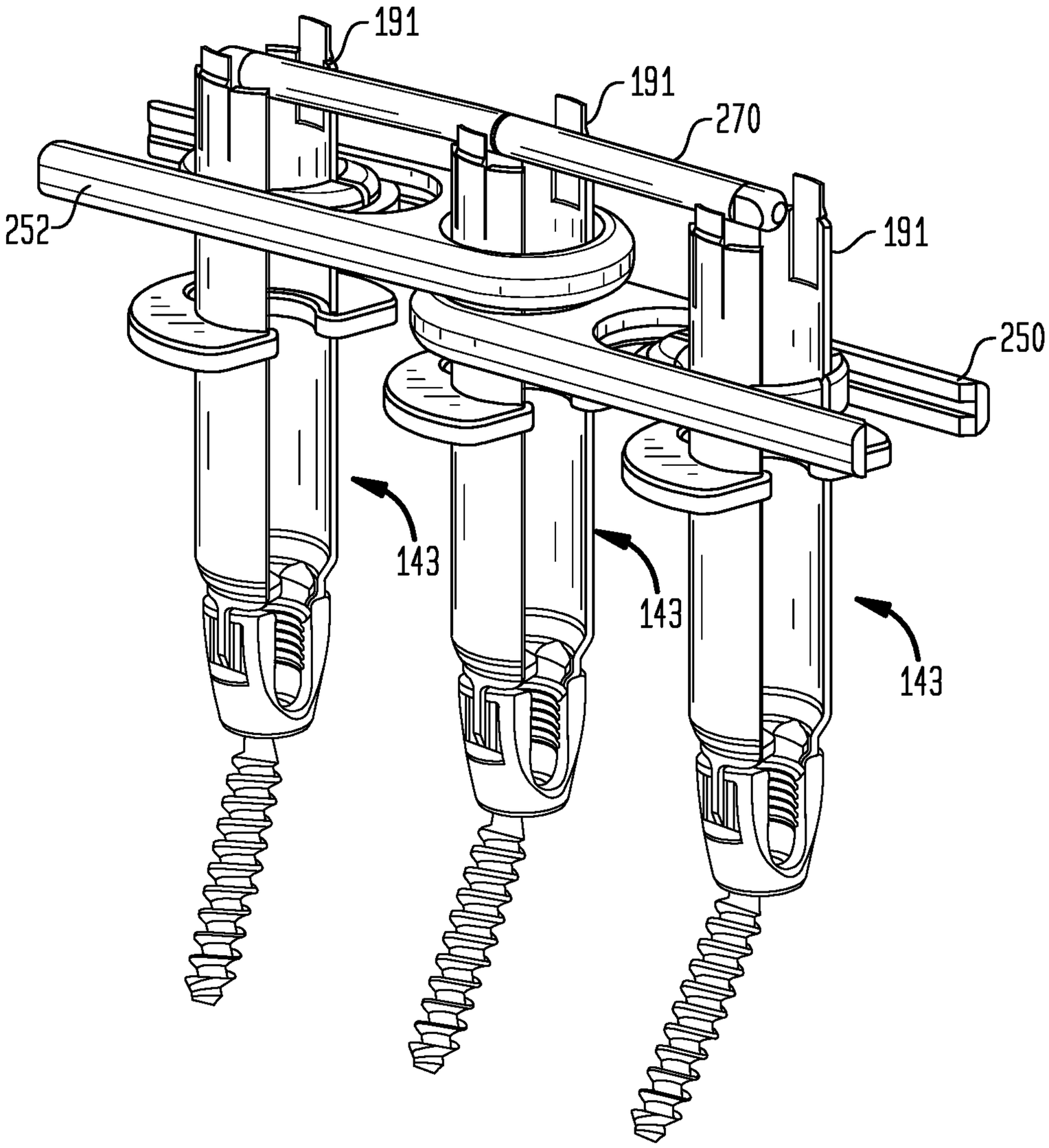


FIG. 17

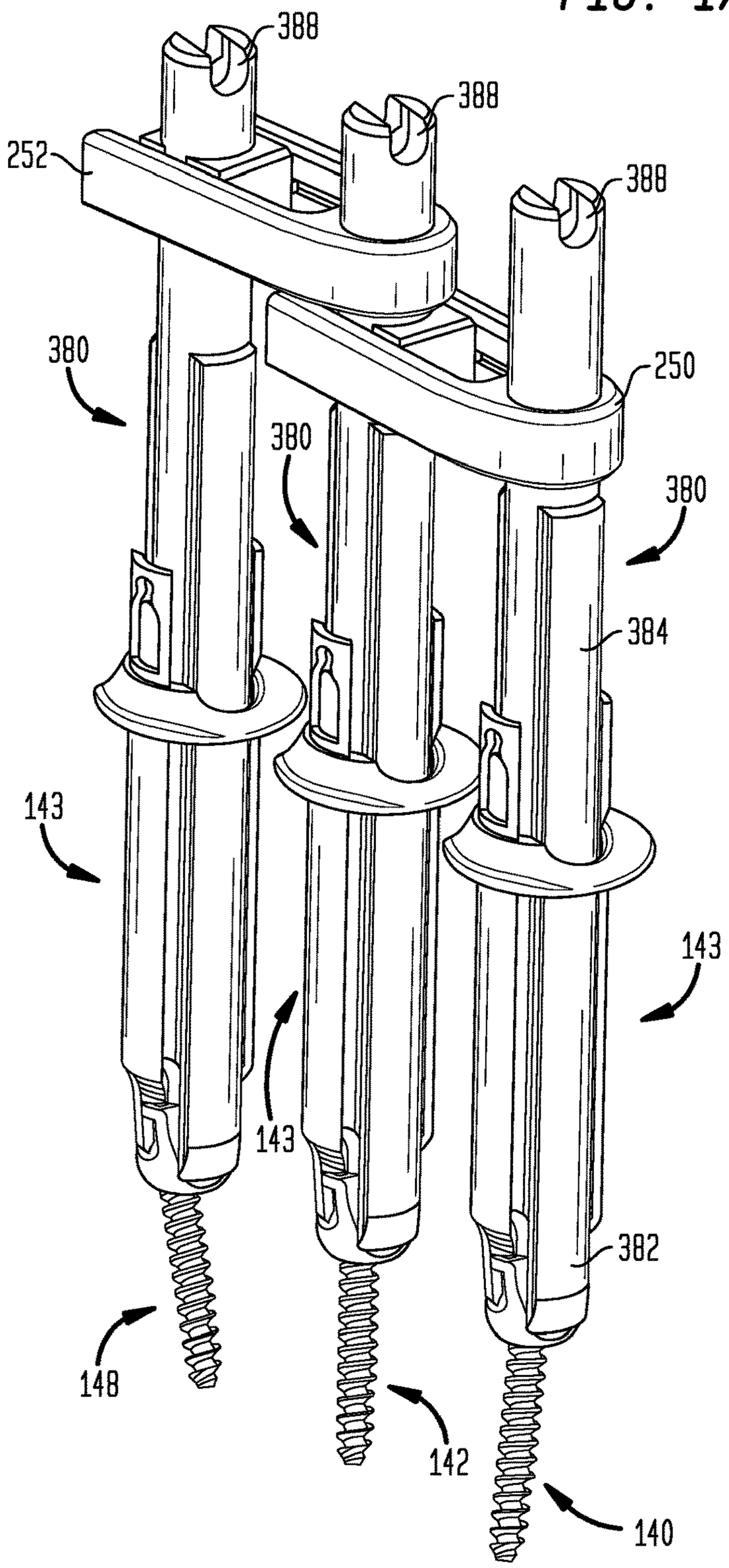


FIG. 18

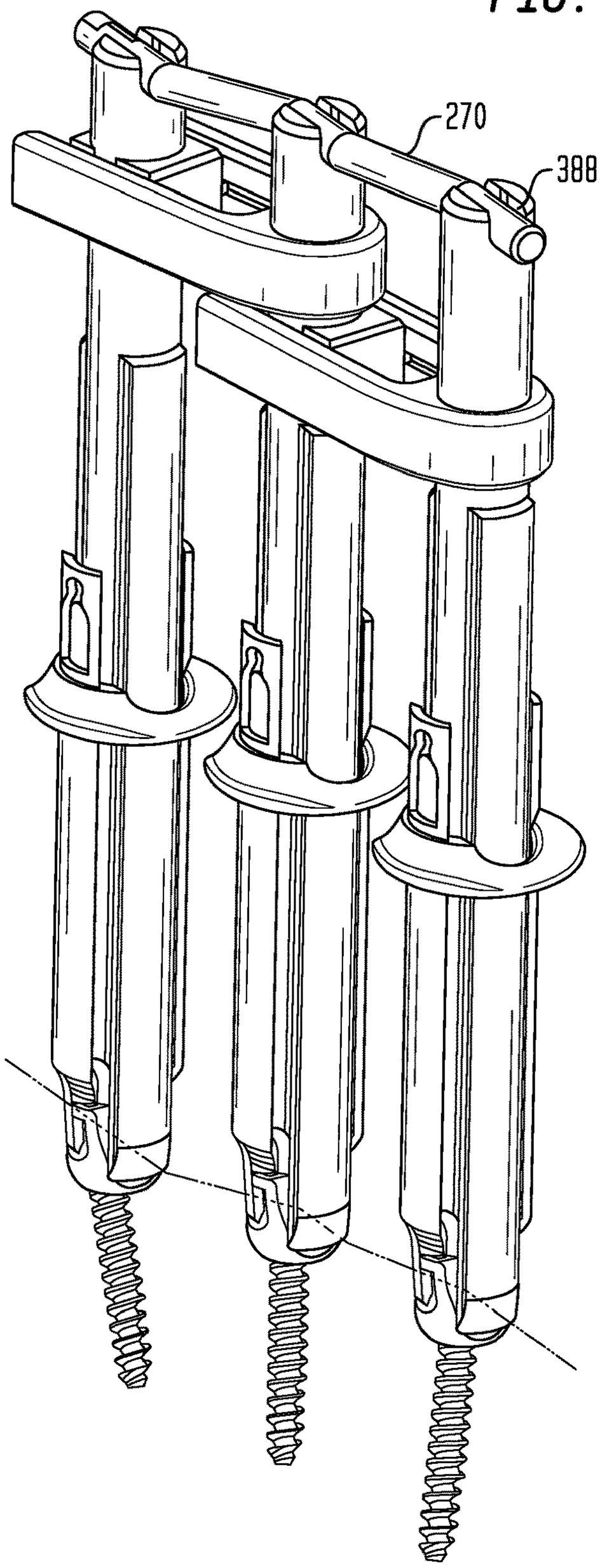


FIG. 19

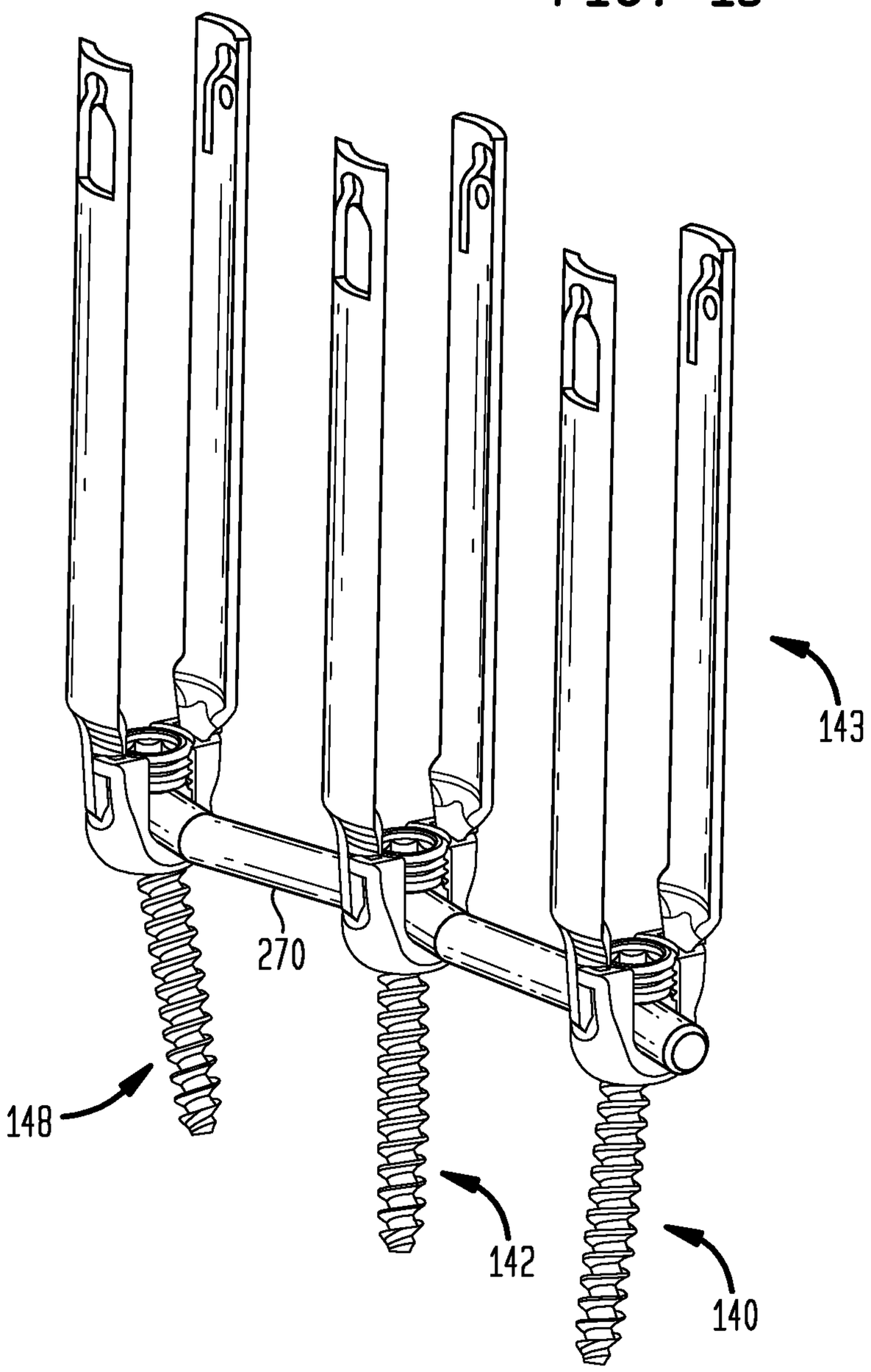
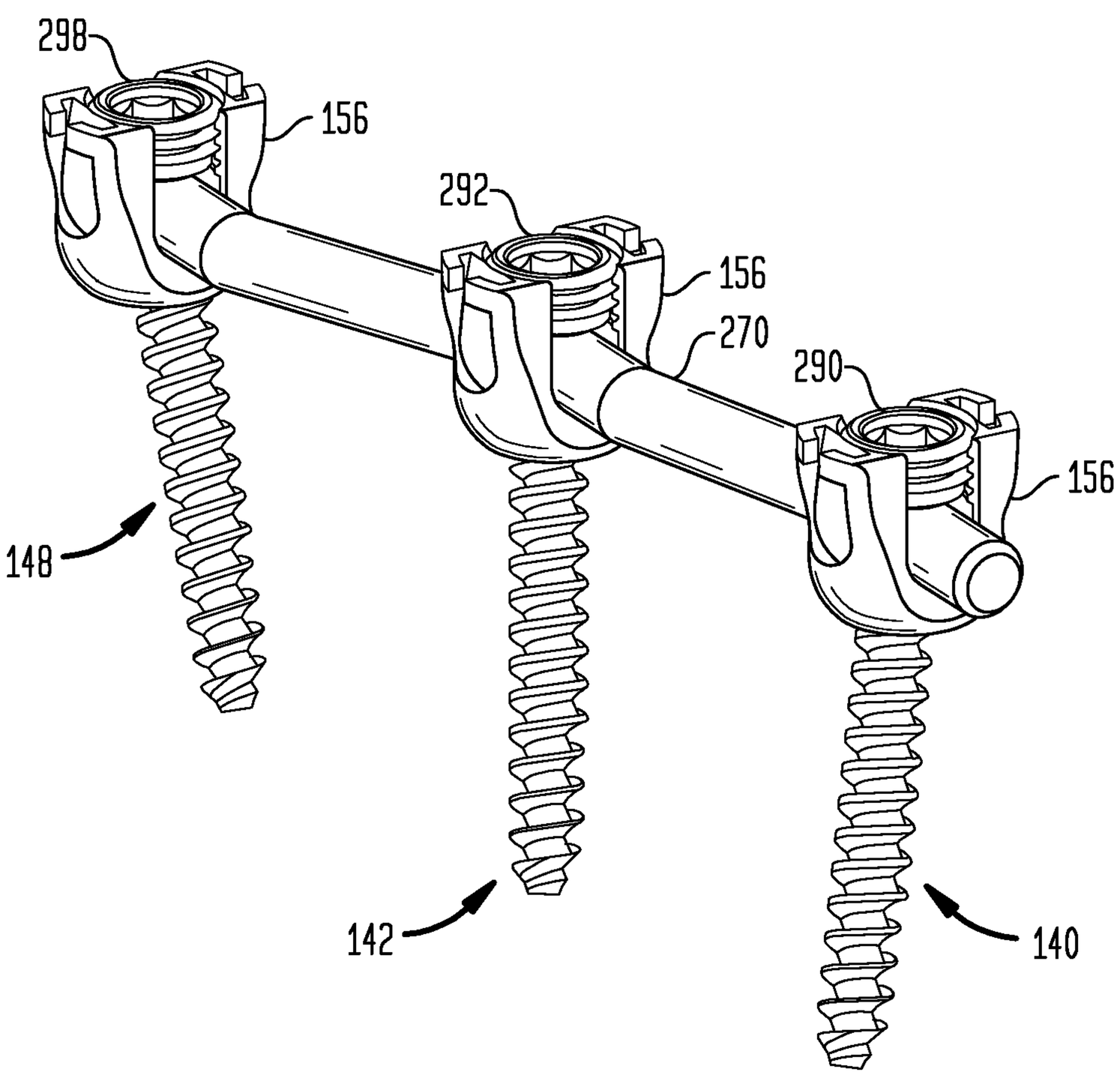


FIG. 20



ROD CONTOURING APPARATUS FOR PERCUTANEOUS PEDICLE SCREW EXTENSION

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 15/000,642, filed Jan. 19, 2016, which is a continuation of U.S. application Ser. No. 12/316,637, filed on Dec. 15, 2008, now U.S. Pat. No. 9,247,977, which is a divisional of U.S. application Ser. No. 11/526,785, filed on Sep. 25, 2006, now U.S. Pat. No. 8,894,655, and claims the benefit of the filing date of U.S. Provisional Application No. 60/765,606, filed Feb. 6, 2006, the disclosures of which are hereby incorporated herein by reference.

This application relates to U.S. Application Ser. No. 10/868,075, entitled "Methods and Devices For Improving Percutaneous Access In Minimally Invasive Surgeries" and filed on Jun. 15, 2004, now U.S. Pat. No. 7,955,355; U.S. application Ser. No. 11/178,035, entitled "System and Method For Orthopedic Implant Configuration" and filed on Jul. 8, 2005, now U.S. Pat. No. 8,177,817; U.S. application Ser. No. 11/202,487, entitled "System and Method For Spinal Implant Placement" and filed on Aug. 12, 2005, now U.S. Pat. No. 8,002,798; and International Application No. PCT/US2004/036640 and filed on Nov. 4, 2004, published as International Publication Number WO 2005/072081, the disclosures of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention relates to methods and devices for improving percutaneous access in minimally invasive surgeries, and more particularly to methods and devices that provide a template for the extracorporeal selection and contouring of connecting devices based on landmark locations within the body, and the percutaneous transfer of connecting devices and instruments, particularly such selected or contoured devices, within one or more access channels to positions defined by particular locations within the body.

It is well known that traditional surgical procedures in locations deep within a patient's body require a long incision, extensive muscle stripping, prolonged retraction of muscles for visualization, and denervation and devascularization of the adjacent tissue. These procedures result in extensive tissue traumatization and consequently in prolonged recovery time, risk of infections, high hospitalization costs, pain that can be more severe than the pain due to the initial ailment, and in some cases permanent scarring. In minimally invasive surgical procedures, portals are used to access the locations deep in the patient's body. The use of portals rather than a long incision causes less trauma to the adjacent tissue, reduces the recovery time and pain and may be performed in some case under only local anesthesia. The avoidance of general anesthesia reduces post-operative recovery time and the risk of complications.

Minimally invasive surgical procedures are especially desirable for spine surgeries because spine pathologies are located deep within the body without clear muscle planes and there is danger of damaging the adjacent neural and vascular tissues. In treating the majority of spinal pathologies, the spinal muscles are stripped from the bony elements of the spine followed by laminectomy to expose the dura, the nerve roots, and the discs. The incision has to be wide enough and the tissues have to be retracted to maintain a

channel from the skin to the floor of the spinal canal that will allow direct visualization. This is similar to an open surgery approach to the knee to expose the menisci versus minimally invasive alternatives such as an arthroscopy which uses 1 centimeter portals under illuminated magnification which results in improved visualization, reduced postoperative knee pain, recovery time, and the destruction of healthy tissue. The destruction to the spinal structures is even more extensive during fusion procedures, which require more lateral tissue dissection and exposure to access the transverse processes and pedicles for placement of pedicle screws, rod constructs for stability, and bone graft under direct vision.

Furthermore, in spine fusion procedures, connecting elements, such as rods, plates or wires are placed and fixed between two or more locations of the spine. Placement of these connecting elements requires open surgery, which is currently one of the major limitations of other percutaneous cannula access methodologies. Accordingly there is a need for inserting and placing these connecting elements between two or more separate spinal locations without performing open surgery.

A wide variety of orthopedic implants exist. Such implants are typically anchored to bones within the body. Every person has different bone structure; accordingly, implants must vary considerably in geometry to meet the needs of a broad range of patients. Connecting elements are an example of an orthopedic implant that often must be specially configured, adjusted, or selected based on the internal anatomical configuration of the patient's bone structure. Although visualization methods such as X-Rays and fluoroscopy can be utilized to help determine bone geometry, contact with the bones must often be made in order to provide a sufficiently accurate measurement of bony landmarks.

Trial fittings of an implant within the body are often required. In open treatment procedures, access to the operation site is typically sufficiently large to allow fitting and adjustment of implants such as connecting devices within the body. This is not feasible in minimally invasive surgical procedures because the surgeon has neither the physical access nor visibility required to test and adjust the device in situ.

According to new minimally invasive surgical (MIS) procedures, many orthopedic implants can be secured to bone through relatively small incisions. Unfortunately, if a larger incision must be made to permit bone measurement and implant selection or configuration, most of the beneficial effects of the MIS implantation procedure will be lost. Accordingly, there is a need in the art for bony landmark measurement and implant selection or configuration methods that can be carried out through small incisions. Such methods should be relatively simple and quick to perform, with comparatively simple instrumentation.

Furthermore, there is a need to provide a system, apparatus and method that solves the combined problems of using minimally invasive surgery for inserting and fastening implants such as connecting elements to bone locations such as spinal vertebrae and also allows configuration of the implants based on internal landmarks locations without performing open surgery.

SUMMARY OF THE INVENTION

In one aspect, the invention features apparatus for use as connectable portals in percutaneous minimally invasive surgery performed within a patient's body. The apparatus

includes a first elongated hollow tube having a proximal end and a distal end and defining a first working channel between the proximal end and the distal end when placed within the body cavity and a second working channel transverse to said first working channel comprising two slots along the length of the hollow tube.

In another aspect, the invention features at least a second elongated hollow tube having a proximal end and a distal end and defining a first working channel between the proximal end and the distal end when placed within the body cavity and a second working channel transverse to said first working channel comprising two slots along the length of the hollow tube.

In another aspect of the invention the first and second tubes are sized for delivering carrier devices, surgical instruments, medical devices, fixation devices, vertebral disc replacement devices, interbody devices, fixation tools, connecting devices, connecting tools, tissue, grafting material, or illumination devices, to a pathology location within the body cavity through either the first or second working channels. The surgical instruments may be scissors, scalpels, saws, drills, tissue dilators, biting and grabbing instruments, curettes, knot tying, or cautery. The fixation devices may be screws, hooks, loops, pins, nuts, washers, wires, sutures, or staples. The fixation tools may be screw drivers, pushers, holders, wrenches, staplers, or knot tiers. The connecting devices may be plates, rods, wires, vertebral disc replacements, interbody fusion devices, or articulating versions thereof. The connecting tools may be connecting tools carriers, pushers, screw drivers, and wrenches. The illumination devices may be light sources, fiber optic cables, infrared detectors, magnification devices, and microscopes. The tubes may further comprise a mechanism for engaging and disengaging a fixation device. The tubes may further comprise separable components that can be assembled and disassembled while at least partially within the body.

In an embodiment of the invention the first tube and second tube may comprise appendages at the distal end configured to releasably engage features of the fixation device and secure to the fixation device.

In an aspect of the method of the invention, the first tube comprises a first opening extending the entire width of the first tube and being located in a portion of the first tube within the first body cavity and wherein a cutting tool is used to incise tissue around the first body cavity through the first opening. The method may also include inserting a second elongated hollow tube within a second body cavity of the patient adjacent to the first body cavity, wherein the second tube has a proximal end and a distal end and defining a second working channel between the proximal end and the distal end when placed within the second body cavity. The method also includes incising tissue between the first body cavity and the second body cavity, thereby forming a path extending from the first body cavity to the second body cavity, then inserting a connecting device into or through the first tube and then transferring the connecting device from the first tube to the second tube through the path. The method also includes attaching a first end of the connecting device to a first bone within the first body cavity via a first fixation device and attaching a second end of the connecting device to a second bone within the second body cavity via a second fixation device. The first bone within the first body cavity may be a first vertebra, and the second bone within the second body cavity may be a second vertebra. The first and second fixation devices may be screws, hooks, loops, pins, nuts, washers, wires, sutures, or staples and in a preferred embodiment is a multiaxial pedicle screw. The connecting device may be plates, rods, wires or articulating versions thereof and in a preferred embodiment is a rod. The tissue between the first and the second body cavities may be a lumbodorsal fascia and the path is located either above or below the lumbodorsal fascia. The first and second tubes are sized for delivering carrier devices, surgical instruments, fixation devices, fixation tools, connecting devices, connecting tools, tissue, grafting material, or illumination devices, to a pathology location within the body cavity. The method may also include inserting additional elongated tubes within additional body cavities of the patient adjacent to the first and second body cavities. The method may also include making a second incision on a second location of the patient's skin, then advancing a second guide wire through the second incision, through tissue underlying the second location and into a second underlying bone, then forming the second body cavity around the second guide wire and finally removing the first and second tubes from the first and second body cavities and closing the first and the second incisions.

The present invention has applications in a wide range of surgical procedures, and in particular in spinal procedures such as laminotomy, laminectomy, foramenotomy, facetectomy and discectomy, fusions or disc replacements using an anterior, posterior, postero-lateral, or a lateral approach to the disc space, facet, laminas, pedicles, or transverse processes. The devices and instruments of the present invention have application to surgical techniques that permit each of these several types of surgical procedures to be performed via a single or multiple sequential working channels. The present invention also has application to surgical techniques for preparing a disc space for insertion of an implant into the disc space.

In another aspect, the invention performs a function similar to a surgical navigation system with simple manual instruments that create a mechanical analog of the body target sites outside the body. This invention further provides a convenient template for the shaping of an implantable device to mate with target body sites without requiring a full surgical exposure to access the target body sites. This invention also provides a suitable level of positional control of the template to allow the surgeon discretion in positioning the template and shaping the implantable device.

In a still further aspect the invention provides an apparatus and a method for creating an extracorporeal set of reference features that replicates the spatial positioning of a set of target sites located inside the body, outside of the body. The target sites are preferably anchor sites for an implantable fixation device, but could be preferred locations for delivering therapeutic agents or anatomic locations.

In one embodiment, the invention creates extracorporeal references of the preferred anchor sites within the body for a fixation member to attach to bone anchors applied to the spine. This is accomplished by attaching elongate members to each bone anchors. Typically the members are attached to a first portion of a bone anchor that articulates with respect to a second portion of the bone anchor that is anchored to the bone. In the case of the application of the invention to a spine surgery, the anchors can be a pedicle screw or a pedicle hook for example.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and description below. Other features, objects and advantages of the invention will be apparent from the following description of the preferred embodiments, the drawings and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments of the present invention will now be discussed with reference to the appended drawings. It is

appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope.

FIG. **1** is a perspective view of two adjacent vertebrae of a spine, with guide wires implanted in the pedicles of the right side.

FIG. **2** is a perspective view of three guide wires in isolation, positioned as though implanted in the pedicles of the right sides of three adjacent vertebrae.

FIG. **3** is a perspective view of the guide wires of FIG. **2**, with dilators advanced along the guide wires to dilate surrounding tissue.

FIG. **4** is a perspective view of the guide wires and dilators of FIG. **3**, with cannulas positioned around the dilators.

FIG. **5** is a view as in FIG. **4** with the dilators removed.

FIG. **6** is a perspective view of the guide wires and cannulas of FIG. **5**, with pedicle screws implanted in a pedicle along a guide wire through the use of an insertion tool.

FIGS. **7** and **7**A are perspective views of guide wires, pedicle screws and an insertion tool as in FIG. **6**, with retractor blades having distal ends engaged with the pedicle screws and retained in position by abutment members to form a slotted cannula.

FIG. **8** is a perspective view of the retractor blades, abutment members and pedicle screws of FIG. **7**, with trough simulation members used to form assemblies for contouring a fixation member attached to the distal portion of the retractor blades.

FIG. **9** is a perspective view of the assemblies of FIG. **8**, with links bridging between the trough simulation members to retain the assemblies in an axially parallel relationship.

FIG. **10** is a perspective view of the cannulas, pedicle screws, trough simulation members, and bridges of FIG. **9**, with a fixation member in the form of a rod seated in troughs of the simulation members for contouring.

FIG. **11** shows the contoured rod being percutaneously guided through the retractor blades toward the pedicle screws.

FIG. **12** is a perspective view of the contoured rod, seated in the pedicle screws and being fastened by bolts using a driving tool.

FIG. **13** is a perspective view as in FIG. **14** of the contoured rod fastened to the pedicle screws.

FIG. **14** is a perspective view as in FIG. **15** of the contoured rod fastened to the pedicle screws after removal of the retractor blades.

FIG. **15** is a perspective view as in FIG. **9** except that the trough simulation members are not used and the links engage the retractor blades to retain the assemblies in an axially parallel relationship.

FIG. **16** is a perspective view as in FIG. **10** showing that the distal portion of the retractor blades may be used in place of the troughs for contouring the rod.

FIG. **17** is a perspective view of the assemblies as in FIG. **8**, with extenders that replace the trough simulation members and pass through the slotted cannulas to provide a contouring feature.

FIG. **18** is a perspective view of the cannulas, pedicle screws, extenders, and bridges of FIG. **17**, with a fixation member in the form of a rod seated in troughs of the simulation members for contouring.

FIG. **19** is a perspective view as in FIG. **18** of the contoured rod fastened to the pedicle screws.

FIG. **20** is a perspective view as in FIG. **19** of the contoured rod fastened to the pedicle screws after removal of the retractor blades.

DETAILED DESCRIPTION

In this application, an "anatomic point" is a location within the body. An anatomic point need not be located on any specific anatomic structure. When applied to anatomy, "proximal" refers to a position relatively closer to the center of the body, and "distal" refers to a position relatively further from the center of the body. However, when referred to a tool or similar implement, "proximal" refers to a portion relatively nearer the operator of the tool or similar implement, and "distal" refers to a portion relatively further from the operator.

The phrase "spatial transformation" refers to any mathematical procedure in which one or more coordinates can be transformed in a manner that permits the original coordinates to be determined based on the results of the transformation. Accordingly, a spatial transformation may involve any combination of translation and rotation of the original coordinates, as long as the transformation can be analytically reversed to permit the original coordinates to be obtained. A "translational spatial transformation" is a spatial transformation in which the original coordinates are all uniformly translated along the same vector.

The term "mate" refers to any type of connection in which cooperating features engage each other to restrict relative motion of the mating parts. The term "couple" is not limited to fixed attachment, but also includes sliding attachment and the like. The term "receive" does not require one item to completely capture another; rather, one item receives another if the first item engages the second item in a manner that restricts relative motion of the items. The term "substantially parallel" means that a range of adjustment is available for limited relative movement of the assemblies, as the surgeon requires, to position the assemblies and also encompasses normal mechanical tolerances and deflections that create variance from geometrically parallel assemblies.

Referring to FIG. **1**, a perspective view illustrates a portion of a spine **10**. FIG. **1** illustrates only the bony structures; accordingly, ligaments, cartilage, and other soft tissues are omitted for clarity. The spine **10** has a cephalad direction **12**, a caudal direction **14**, an anterior direction **16**, a posterior direction **18**, and a medial/lateral axis **20**, all of which are oriented as shown by the arrows bearing the same reference numerals. In this application, "left" and "right" are used with reference to a posterior view, i.e., a view from behind the spine **10**. "Medial" refers to a position or orientation toward a sagittal plane (i.e., plane of symmetry that separates left and right sides from each other) of the spine **10**, and "lateral" refers to a position or orientation relatively further from the sagittal plane.

As shown, the portion of the spine **10** illustrated in FIG. **1** includes a first vertebra **24**, which may be the L5 (Fifth Lumbar) vertebra of a patient, and a second vertebra **26**, which may be the L4 (Fourth Lumbar) vertebra of the patient. The systems and methods may be applicable to any vertebra or vertebrae of the spine **10** and/or the sacrum (not shown). In this application, the term "vertebra" may be broadly interpreted to include the sacrum.

As shown, the first vertebra **24** has a body **28** with a generally disc-like shape and two pedicles **30** that extend posteriorly from the body **28**. A posterior arch, or lamina **32**, extends between the posterior ends of the pedicles **30** to couple the pedicles **30** together. The first vertebra **24** also has

a pair of transverse processes **34** that extend laterally from the pedicles **30** generally along the medial/lateral axis **20**, and a spinous process **36** that extends from the lamina **32** along the posterior direction **18**.

Similarly, the second vertebra **26** has a body **48** from which two pedicles **50** extend posteriorly. A posterior arch, or lamina **52**, extends between the posterior ends of the pedicles **50** to couple the pedicles **50** together. The second vertebra **26** also has a pair of transverse processes **54**, each of which extends from the corresponding pedicle **50** generally along the medial/lateral axis **20**, and a spinous process **56** that extends from the lamina **52** along the posterior direction **18**.

The vertebrae **24**, **26** and/or the intervertebral disc (not shown) between them, may be damaged or diseased in some manner that makes it desirable to secure the vertebrae **24**, **26** together in a manner that prevents relative motion between them. Accordingly, posterior spinal fusion may be employed to secure the pedicles **30** and **50** together in a geometrical relationship that produces a fused spinal section with an appropriate bio-mechanical function. In order to allow the surgeon to provide a proper geometrical relationship between vertebrae, multiaxial pedicle screws and contoured rods connecting the screws have become the gold standard for spinal fusion hardware. FIGS. **1** through **16** illustrate an apparatus and method of configuring and installing a posterior spinal fusion system. FIGS. **17** through **20** illustrate an alternate embodiment for contouring the fixation member.

As further illustrated in FIG. **1**, a first guide wire **70** has been inserted into the right-side pedicle **30** of the first vertebra **24**, and a second guide wire **72** has been inserted into the right-side pedicle **50** of the second vertebra **26**. The guide wires **70**, **72** pass through the saddle points **42**, **62**, respectively, of the pedicles **30**, **50**. Each of the guide wires **70**, **72** has a proximal end **74** and a distal end **76**. As shown, the proximal ends **74** are exposed, and the distal ends **76** are implanted in the pedicles **30**, **50**. The distal ends **76** may be implanted by methods known in the surgical arts.

Referring to FIG. **2**, a perspective view illustrates the first and second guide wires **70**, **72** of FIG. **1**, with the vertebrae **24**, **26** not shown for clarity. The vertebrae are not shown for clarity in the subsequent FIGS. **3-20** also. A third guide wire **78** is also shown. The third guide wire **78** is positioned adjacent to the first and second guide wires **70**, **72** as though the third guide wire **78** were implanted in the right-hand pedicle of a vertebra (not shown) directly superior to the second vertebra **26**. Accordingly, the method of FIGS. **1** through **20** may be used to secure together vertebrae on multiple levels, not just two adjacent vertebrae.

Referring to FIG. **3**, a perspective view illustrates the guide wires **70**, **72**, **78**, in conjunction with a first dilator **80**, a second dilator **82**, and a third dilator **88**. Each of the dilators **80**, **82**, **88** has a proximal end **92** and a distal end **94**. The proximal ends **92** may be shaped for gripping by hand, or for attachment to a handle or the like. The distal ends **94** are rounded to permit relatively gentle spreading of tissues surrounding the guide wires **70**, **72**, **78** by the dilators **80**, **82**, **88**.

Each of the dilators **80**, **82**, **88** has a bore sized to receive the proximal end **74** of the corresponding guide wire **70**, **72**, or **78**, so that the dilators **80**, **82**, **88** are able to slide along the guide wires **70**, **72**, **78** toward the distal ends **74**, thereby spreading the tissues away from the guide wires **70**, **72**, **78**. As an alternative to the guide wires **70**, **72**, **78** and the dilators **80**, **82**, **88**, a variety of other guiding devices and/or dilation devices may be used within the scope of the present invention.

Referring to FIG. **4**, a perspective view illustrates the guide wires **70**, **72**, **78** and dilators **80**, **82**, **88**, with the addition of a first cannula **100**, a second cannula **102**, and a third cannula **108**. Each of the cannulas **143** has a proximal end **112**, a distal end **114**, with a bore passing between the proximal and distal ends **112**, **114**. Each proximal end **112** has a port **116** in communication with the bore, and a tab **118** that may facilitate manipulation or securement of the corresponding cannula **100**, **102**, or **108**.

Each distal end **114** has a taper **122** that provides a reduction in the diameter of the cannula **100**, **102**, or **108** toward the distal end **114**.

The cannulas **143** are inserted around the guide wires **70**, **72**, **78**. The cannulas **143** may be placed by withdrawing dilators **80**, **82**, **88**, inserting the cannulas **143** around the proximal ends **74** of the guide wires **70**, **72**, **78**, inserting the distal ends **94** of the dilators **80**, **82**, **88** into the ports **116** of the proximal end **112** of the cannulas **143**, and then advancing the dilators **80**, **82**, **88** along the guide wires **70**, **72**, **78** to urge the cannulas **143** toward the distal ends **76** of the guide wires **70**, **72**, **78**, into the dilated tissue.

According to one alternative method, the dilators **80**, **82**, **88** are removed to permit placement of the cannulas **143**, and are not re-inserted. According to other alternative embodiments, cannulas (not shown) may be modular, or may have dilatable distal ends that enable placement of the cannulas around the dilators **80**, **82**, **88**, so that the dilators **80**, **82**, **88** need not be removed from the guide wires **70**, **72**, **78** until the cannulas are properly positioned. The present invention is not limited to use of cannulas like those of FIG. **4**; rather, any of a variety of cannulas may be used.

Referring to FIG. **5**, a perspective view illustrates the guide wires **70**, **72**, **78** and cannulas **143**, after the dilators **80**, **82**, **88** have been removed.

FIG. **6** is a perspective view showing the addition of the first of three cannulated connection elements **140** installed through the cannula **100** and into the vertebra using an insertion tool **170**.

The connection elements may be fixation members designed to anchor a rod to the first vertebra **24**, the second vertebra **26**, and the third vertebra (not shown in FIG. **6**). More precisely, the connection elements may be pedicle screws **140**, **142**, and **148** implantable in vertebral pedicles, as shown in FIG. **7**.

The pedicle screws **140**, **142**, **148** may be designed to provide poly-axial coupling to the associated pedicles. Each of the pedicle screws **140**, **142**, **148** has a cage **152** shaped to receive a rod and a screw **154** that passes through an aperture (not visible) of the cage **152** in such a manner that the screw **154** is able to extend from the cage **152** along a plurality of relative orientations. Thus, after the screw **154** has been implanted in a pedicle, the orientation of the cage **152** with respect to the screw **154** can still be altered. Each of the screws **154** has a lumen passing along the axis of the screw **154** so that the screws **154** can slide along the guide wires **70**, **72**, **78** for accurate implantation in the pedicles.

As seen in FIG. **8**, each cage **152** has two arms **156** that extend generally away from the screw **154** and define a trough **158** through which a rod (not shown in FIG. **5**) can pass. The closed end of the trough **158** is rounded in a manner that corresponds to the radius of the rod to be retained within the cage **152** to facilitate secure retention of the rod. The inward-facing surfaces of the arms **156** may be threaded to enable the arms **156** to receive a nut (shown in FIG. **14**). Tightening of the nut then presses the rod against the head **154** (shown in FIG. **14**) of the screw **154** to keep

the rod in place within the slot **158** and to lock the orientation of the screw **154** with respect to the cage **152**.

The pedicle screws **140**, **142**, **148** represent only one of many types of connection elements that may be used in connection with the present invention. A variety of known devices may be used to secure a rod to a plurality of vertebra to provide posterior fusion.

Upon implantation in the pedicles, the pedicle screws **140**, **142**, **148** are positioned such that a first anatomic point **164**, a second anatomic point **166**, and a third anatomic point **168** are within the troughs **158** of the cages **152** of the first pedicle screw **140**, the second pedicle screw **142**, and the third pedicle screw **148**, respectively. Upon installation of the rod in the troughs, the axis of the rod is to pass through the anatomic points **164**, **166**, **168**.

Referring back to FIG. **7**, seen extending from the connecting element **140**, is a slotted cannula **143** and an abutment member **145**. The cannula **143** is used to maintain access to the connecting element **140** after it has been implanted in the pedicle in a manner that facilitates percutaneous placement of the rod and attachment of the rod to the connecting element **140**. The abutment member **144** helps to hold the cannula **143** together and keep it secured to the connecting element **140** in a manner that will be described subsequently. Additional cannulas **143** can be attached to pedicle screws **142** and **148**.

Prior to the installation of the connecting element **140** shown in FIG. **6**, the slotted cannula **143** is assembled to the connecting element **140** as visible in FIG. **7**. Upon assembly, the cannula **143** will have a proximal end **191** and a distal end **192**. The cannula **143** may be dimensioned such that the proximal end **190** protrudes above the skin while the distal end **192** is securable to the cage **152** and is insertable through the skin along with the cage **152**. The cannula **143** includes a first retractor blade **195** and a second retractor blade **197**, which may be substantially identical to each other. Each of the blades **195**, **197** has a proximal end corresponding to the proximal end **191** of the cannula **143**, and a distal end corresponding to the distal end **192** of the cannula **143**.

The retractor blades are detachably attached to the first portion of the bone anchor as shown in FIGS. **7** and **7**A. Each distal end **192** has a distal tab **202**, and each proximal end **191** has a proximal tab **204**. Each distal tab **202** has a locking ridge **206** that protrudes generally outward, and extends generally circumferentially. Each distal tab **202** is also elongated, with a thin cross section that permits bending toward and away from the axis (not shown) of the cannula. Each proximal tab **204** has bends **208** that cause proximal tab **204** to jut outward, while remaining generally parallel with the remainder of the corresponding blade **195** or **197**.

Each of the distal tabs **202** is insertable through the slot **174** of the adjacent arm **172** of the cage **152** when the corresponding blade **195** or **197** is tilted to position the proximal end inward relative to the distal end. Once the distal tabs **202** have passed through the slots **174**, rotation of the blades **195** or **197** back to a position generally parallel to each other, and to the axis of the cage **152**, causes the distal tabs **202** to engage the edge of the slots **174** such that the bends **208** in the tab **202** are unable to slide back through the slots **174**. Thus, the blades **195** and **197** are then in a locked configuration, and cannot be detached from the cage **152**. When they are again moved to the unlocked configuration, i.e., tilted to a position with the proximal ends **191** inward, the retractor blades can be unlocked and detached.

As long as the blades **195**, **197** remain generally parallel to each other, the distal end **192** of the cannula **143** remains secured to the cage **152**. Thus, the distal tabs **202** form a docking element that removably secures the cannula **143** to the connecting element **140**. The abutment member **145** serves to keep the blades **195**, **197** parallel to each other to keep the cannula **143** in assembled form and to simultaneously keep the cannula **143** secured to the cage **152** by keeping the blades **195**, **197** from rotating into the unlocked configuration. When the cannula **143** is secured to the cage **152**, the cannula **143** is in its "docked configuration." When the cannula **143** is removed from the cage **152**, the cannula **143** is in its "undocked configuration."

As shown, the abutment member **145** is generally disc-shaped with a central opening and an open side that provides access to the central opening. The abutment member **145** also has a pair of arcuate slots that extend around opposing portions of the central opening and are sized to surround the first and second blades **195**, **197** and keep the blades generally parallel to each other, and perpendicular to the abutment member **145**. Thus, the blades **195**, **197** are unable to pivot to the unlocked configuration when the abutment member **145** is installed to create an assembly and the cannula **143** maintains a generally tubular shape.

After the blades **195**, **197** have been inserted into the arcuate slots, the abutment member **145** may be positioned at any of a range of positions along the cannula **143**. Thus, upon implantation of the pedicle screw **140** in the corresponding pedicle, the abutment member **145** can be positioned abutting the outward-facing surface of the patient's skin through which the cannula **143** passes. The abutment member **144** helps to stabilize the cannula **143** with respect to the tissues it passes through.

Once assembled to the pedicle screw **140**, the cannula **143** has slots **220** extending along its entire longitudinal length, along opposite sides of the cannula **143**. The slots **220** extend to the cage **152**, and are therefore contiguous with the recesses defined in the arms **172** of the cage **152**. Upon installation of the cannula and pedicle screw assembly by using the cannula **100** and tool **170** as shown in FIG. **6**, the slots **220** will extend along the entire subcutaneous length of the cannula **143** as better seen in FIG. **8**. Therefore, the rod for connecting the pedicle screws **14**, **142**, **148** may be inserted percutaneously through the slots **220** along a direction transverse to the axis of the cannula **143**, and may then be moved through the slots **220** along the anterior direction **16**, directly into the trough of the cage **152**.

The pedicle screws **140**, **142**, **148**, with or without the assembled cannulas **143**, may be installed in a variety of ways. According to one method, the dilators **80**, **82**, **88** are first removed. Then, each of the pedicle screws **140**, **142**, **148** is implanted through the use of an insertion tool **170**. The insertion tool **170** has a handle **172** designed to be gripped by a hand, a distal end extending from the handle **172** and engaging the head of each of the screws **154**. Thus, torque applied to the handle can be transmitted to each of the screws **154**.

The stem **174** also has a lumen (not shown) sized to fit around each of the guide wires **70**, **72**, **78** so that the guide wires **70**, **72**, **78** can be used to guide implantation of the screws **154** through the use of the insertion tool **170**. Slots **178** provide access to the lumen for cleaning.

Each of the screws **140**, **142**, **148** is coupled to the insertion tool **170** by connecting the head **154** of the screws to the distal end **176** of the stem **174**. The insertion tool **170** is then moved to insert the proximal end **74** of the corresponding guide wire **70**, **72**, **78** through the lumen of the screw **154** and into the lumen of the stem **174**. The insertion tool **170** is used to insert the pedicle screw **140**, **142**, or **148**

through the corresponding cannula **100**, **102**, or **108** until the screw **154** contacts the first pedicle **30**, the second pedicle **50**, or the third pedicle. Then, torque and axial pressure are applied to the tool **170** to embed the threads of the screw **154** into the bone. The same method may be used to implant all three of the pedicle screws **140**, **142**, **148**. After the pedicle screws **140**, **142**, **148** have been implanted, the guide wires **70**, **72**, **78** may be removed.

As previously discussed, the fixation member in the form of a rod for connecting the pedicle screws **140**, **142**, **148** must be configured in three dimensional space to match the geometrical targets **164**, **166**, **168**, in order to allow the pedicle screws to constrain the vertebrae in the desired positions once they are fastened to the rods. This requires that the rod be contoured. For better precision in contouring the fixation member, simulation members, such as the trough simulation members **180** with base **182**, stem **184** and troughs **188** as shown in FIG. **8**, may be attached to the proximal end **191** of the cannula **143** to better replicate the geometry of the geometrical targets **164**, **166**, **168**. In conjunction with the cannula **143**, the trough simulation members **180** provide a translational spatial transformation of the troughs **158** of the pedicle screws to the troughs **188** in order to use the troughs **188** as an extracorporeal template to bend the rod. The rod will later be attached in the troughs **158** of the pedicle screws **140**,**142**,**148** attached to the vertebrae within the body of the patient, placing the central axis of the rod in the troughs **158** to match the geometrical targets **164**, **166**, **168** at each trough location.

As shown in FIG. **8**, the particular attachment method employed for the trough simulation members **180** attaches the member to each proximal cannula end **191** with a proximal tab **204** releasably engaged with a slot in the trough simulation member. As will be later described, the trough simulation members **180** are but one example of a simulation member and other arrangements that project the positional relationship of the troughs **158** outside the body to achieve a translational spatial transformation, such as rods or cannulas that locate on the troughs **158** directly rather than through a cannula **143** are within the scope of the inventions. Regardless of the configuration of the simulation members, the members must be retained in an approximately parallel axial relationship, be of the same length, and maintain the same alignment of each set of troughs **158** and **188** when using the externally projected troughs **188** to gauge the contouring of the rod in order to provide an accurate translational spatial transformation of the troughs **158** and consequently allow the axis of the contoured rod to correctly fit within the troughs **158** in the geometrical targets **164**, **166**, **168**.

Referring to FIG. **9**, a perspective view illustrates the cannulas **143**, pedicle screws **140**, **142**, **148**, and the trough simulation members **180** of FIG. **8**, with the addition of a first link or bridge **250** and a second link or bridge **252**. The bridges **250**, **252** are used to keep the trough simulation members **180** substantially parallel to each other to constrain the spatial transformation of the anatomic points **164**, **166**, **168**. The bridges **250**, **252** are designed to constrain the trough simulation members **180** only to parallelism. Thus, the bridges **250**, **252** do not limit relative translation or relative axial rotation of the trough simulation members **180**.

Each of the first and second bridges **250**, **252** has a first slider **254** and a second slider **256**. The first slider **254** of each of the bridges **250**, **252** has a pair of grooves **258** that face inward. The second slider **256** of each of the bridges **250**, **252** has a pair of flanges that extend outward into the grooves **258** of the corresponding first slider **254** so that the first and second sliders **254**, **256** are linearly slidable relative to each other to permit lengthening or shortening of the bridges **250**, **252**. Each of the sliders **254**, **256** also has an aperture **262** that fits around the stem **184** of the corresponding trough simulation members **180**. The apertures **262** are sized to fit around the stems **184** with relatively little clearance so that the bridges **250**, **252** keep the trough simulation members **180** and thus the attached cannulas **143** and cages **152** parallel to each other without restricting relative axial rotation between the stems **184** and the apertures **162**.

The bridges **250**, **252** embody only one of many possible configurations that may be used in connection with the invention. According to one alternative embodiment (not shown), each bridge does not have two sliders, but has two members that are rotatably coupled to each other. Each of the members has an aperture like the apertures **262** of the bridges **250**, **252**, so that the bridges can permit relatively free relative translation and axial rotation of the trough simulation members **180**, while keeping the trough simulation members **180** parallel to each other. The bridges would simply elongate and contract through the use of rotary motion instead of linear motion.

Returning to the configuration of FIG. **9**, once the bridges **250**, **252** have been applied, the trough simulation members **180** axially are parallel. The projected points **214**, **216**, **218** then mimic the relative positioning of the anatomic points **164**, **166**, **168** within the body and each pair of real and simulation troughs corresponding to the anatomic and projected points is in the same relative orientation to achieve a translational spatial transformation. Thus, the trough simulation members **180**, in conjunction with the cannulas **143** and cages **152**, apply a translational spatial transformation to the anatomic points **164**, **166**, **168** to move them to a more accessible location without altering their positions relative to each other. Accordingly, a rod contoured such that its axis passes through the projected points **214**, **216**, **218** may be installed such that its axis passes through the anatomic points **164**, **166**, **168** to properly extend through the cages **152** of the pedicle screws **140**, **142**, **148**. An aspect of the invention is that in order for the projected points **214**, **216**, **218** to accurately correspond with the relative positioning of the anatomic points **164**, **166**, **168** within the body, the various mechanical interfaces of the intervening components between the points, such as the trough simulation members **180**, the cannulas **143** and the cages **152**, must have mechanical interfaces with suitable tolerances, such as axial concentricity and fit, to provide the necessary accuracy.

Referring to FIG. **10**, a perspective view illustrates the cannulas **143**, the pedicle screws **140**, **142**, **148**, the trough simulation members **180**, and the bridges **250**, **252** of FIG. **9**, with a rod **270** seated in the trough **180** of the trough simulation members **180** for contouring.

Due to natural variations in spinal morphology, the troughs **158** of the pedicle screws **140**, **142**, **148** may not be arranged in a straight line. Thus, the simulation troughs **180** may not be arranged in a straight line. Consequently, the rod **270** may need to be bent into the proper shape, for example, through the use of tooling such as pliers, French benders, a vice, or the like, so that it will lie properly within simulation trough **180**. The process of deforming the rod **270** to the required shape may be termed "contouring."

Contouring may be carried out by, first, placing the undeformed rod **270** in the troughs **180** to determine how the rod **270** should be deformed to lie properly within the troughs **180**. Then, the rod **270** is deformed, and again

placed in the troughs **180** to check the fit. This process is repeated until the rod **270** is shaped to provide an optimal fit with the troughs **180**.

In the alternative to contouring, the rod **270** may simply be selected from a kit or the like. For example, such a kit (not shown) may include rods bent at a variety of angles. The troughs **180** could be used to select the proper rod from the kit by placing each rod, in turn, on the troughs **180** until one is identified that has the proper fit. As another alternative, the rod **270** may be custom fabricated, for example, by measuring the relative positions of the troughs **180** and using a CNC procedure to form the rod **270**.

After the rod **270** has been configured or selected, the rod **270** and the trough simulation members **180** may be removed from the operating site as shown in FIG. **11**, leaving the pedicle screws **140**, **142**, **148** in place. The cannulas **143** may also be removed at this stage, depending on the method that will be used to implant the rod **270**. The rod **270** may be inserted subcutaneously and placed on the cages **152** by making additional incisions to connect the access passageways provided by the cannulas **143**. Alternatively, MIS (Minimally Invasive Surgical) techniques, as subsequently described, may be used to implant the rod **270** without making additional major incisions, for example, by inserting the rod **270** subcutaneously and subfascially through the slots **220** of the cannulas **143** using a rod holding tool **302**.

As shown in FIGS. **12**, **13** and **14**, the rod **270** has now been seated in the troughs **158** of the cages **152** such that its axis passes through the anatomic points **164**, **166**, **168**. The use of a persuasion tool to seat a rod in a pedicle screw trough is well known in the art. Nuts **290**, **292**, **298** have been rotated into engagement with the inward-facing surfaces of the arms **156** of the cages **152** of the first, second, and third pedicle screws **140**, **142**, **148**, respectively. The nuts **290**, **292**, **298** have been tightened with a tool **304** to press the rod **270** against the heads of the heads **154** of the pedicle screws **140**, **142**, **148**, respectively. Thus, the cages **152** are no longer freely rotatable with respect to the screws **154**, but are instead locked in their current orientations.

The pedicle screws **140**, **142**, **148** thus cooperate with the rod **270** to restrict relative motion of the vertebrae to form a posterior vertebral fusion system. If desired, a similar system may be implanted in the left-side pedicles through the method set forth previously to provide a bilateral system. Additionally, the present invention is not limited to a three-level fusion system, but may be used to fuse any number of vertebrae together. To fuse more than three vertebrae together, the steps set forth above may simply be repeated for each additional vertebra, and the rod may be placed on four or more rod interfaces for configuration or selection.

The foregoing is only one of many methods encompassed within the scope of the present invention. According to one alternative method, the trough simulation members **180** may be omitted entirely from the procedure. Such a method may commence with the steps outlined above in the descriptions of FIGS. **1** through **7**, but may then include the steps illustrated in FIGS. **15** and **16**.

Referring to FIGS. **15** and **16**, a perspective view illustrates that in this embodiment the apertures **262** of the bridges **250**, **252** are sized to fit in close sliding contact with the outer surfaces of the cannulas **143** in order to keep the cannulas parallel to each other. The rod **270** is then manually positioned at the proximal end **191** of the cannula **170** and visually evaluated to conduct the contouring or selection process described in conjunction with FIG. **10**. While not providing the accuracy of an embodiment using simulation members, this method may be used to shorten the time necessary for the contouring step or be may be used to contour a trial rod or may be used for an initial contouring of a rod before using a simulation member.

FIGS. **17** through **20** depict an embodiment that uses a different type of simulation member than the trough simulation members **180** discussed above. As seen in FIG. **17** trough simulation rods **380** project the positional relationship of the troughs **158** outside the body, by passing through cannulas **143** and locating directly on the troughs **158**. The trough simulation rod **380** has a trough interface **382**, an elongate shaft **384** and simulation troughs **388** located at the proximal end of the rod. The trough interface **382** is configured to locate on the troughs **158** of the pedicle screws **140**,**142**,**148** attached to the vertebrae within the body of the patient, in order to determine the position of the geometrical targets **164**, **166**, **168** for the central axis of the rod **270**. The shaft **384** projects the location of the troughs **158** to simulation troughs **388** external to the body and maintains a close concentric fit with the cannula **143** to ensure an accurate projection. Thus, similar to the previous embodiment using the trough simulation members **180**, the trough simulation rods **380** provide a spatial transformation of the troughs **158** of the pedicle screws to the simulation troughs **388** in order to use the troughs **388** as an extracorporeal template to bend the rod. As in the previous embodiment, the trough simulation rods **380** must be retained in an approximately parallel axial relationship by structures such as bridges **250**, **252**, be of the same length, and maintain the same alignment of each set of troughs **158** and **388** when using the externally projected troughs **388** to gauge the contouring of the rod in order to provide an accurate projection of the troughs **158** and consequently allow the axis of the contoured rod to correctly fit with the troughs **158** in the geometrical targets **164**, **166**, **168** as previously described. The rod **270** will later be placed in the body and be attached to the pedicle screws as previously described in connection with FIGS. **11-14** and pictured in FIGS. **18-20**. In the latter series of figures, a three dimensionally contoured rod **270** is depicted.

A typical surgical procedure in accordance with the present invention will now be described. It will be understood by those of ordinary skill in the art that additional or fewer steps may be performed, the sequence of steps can be varied as appropriate and that substitute techniques and methods may be utilized. Nonetheless, during a typical surgery, a surgeon may perform the following steps:

percutaneously installing guide wires in bones, such as adjacent vertebrae, as shown in FIG. **1**,

using blunt dilators and cannulas to open incisions and cavities as shown in FIGS. **2-5**,

percutaneously installing polyaxial screws with retractor blades attached as shown in FIGS. **6**,

removing the cannulas and guide wires as shown in FIGS. **7** and **7**A,

installing the abutment members to form slotted cannula assemblies,

installing the trough simulation members or rods to the cannula assembly and/or the polyaxial screw head to form contouring assemblies as shown in FIG. **8** and alternatively, in FIG. **17**,

aligning the contouring assemblies in a parallel relationship and installing the links onto the assemblies as shown in FIG. **9** and, alternately, in FIG. **17**,

contouring the fixation member to fit the trough simulation members as shown in FIG. **10** or alternatively to fit into the trough simulation rods shown in FIG. **18**,

installing the contoured fixation member percutaneously as shown in FIG. **11**,

fastening the fixation member in the polyaxial screws as shown in FIGS. **12**, **13** and **19**, and

removing the elongate members as shown in FIGS. **14** and **20** and thereafter completing the surgery.

The foregoing description discloses a number of different elements, any of which may be components of a system for configuring or selecting one or more implants for implantation in a body of a patient. Although the foregoing examples relate to the assembly and implantation of a posterior spinal fusion system, the present invention may be applied to a wide variety of implants, within and outside the orthopedic area. The present invention has particular benefits when an implant is to be configured or selected for a given patient, with reference to two or more anatomic points within the body.

Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.

The invention claimed is:

1. A system for configuring or selecting one or more implants and for implanting the implants proximate the spine in the body of a patient, the system comprising:

a first extender having a distal portion and a proximal portion, the first extender being positionable in a first implanted position in which the distal portion of the first extender is positioned proximate a first anatomic point within the body and the proximal portion of the first extender is positioned outside the body, the first anatomic point being located proximate a first pedicle of a first vertebra of the spine;

a second extender having a distal portion and a proximal portion, the second extender being positionable in a second implanted position in which the distal portion of the second extender is positioned proximate a second anatomic point within the body and the proximal portion of the second extender is positioned outside the body, the second anatomic point being located proximate a second pedicle of a second vertebra of the spine; and

a first passageway device having a distal end and a proximal end and having a central longitudinal axis extending therealong between the distal and proximal ends, the distal end of the first passageway device being configured to be positioned proximate the first anatomic point while the distal end is connected to a first pedicle fastener implantable in the first pedicle and while the proximal end extends outside the body, the first passageway device defining a first passageway adapted to receive the first extender therein in a close concentric fit, the first passageway device and the first extender having a mechanical interface to constrain the orientation of the first extender, and the first passageway device defining a first slot and a second slot extending along the central axis from the distal end to the proximal end, the first and second slots of the first passageway device being arranged to permit passage of the one or more implants therethrough along a direction transverse to the central axis;

wherein the proximal portion of each of the first and second extenders includes a respective rod interface defining respective first and second projected points outside the body, the rod interfaces being shaped to receive a rod in a position extending simultaneously through the first and second projected points when the first and second extenders are positioned in the respective first and second implanted positions.

2. The system of claim **1**, further comprising the first pedicle fastener, wherein the distal end of the first passageway device has a docking element discrete from and securable to the first pedicle fastener.

3. The system of claim **2**, wherein the first pedicle fastener includes a pedicle screw having a cage connected thereto, the cage being configured to receive at least a portion of the one or more implants, and wherein the docking element comprises a plurality of tabs receivable in corresponding slots of the cage of the first pedicle fastener.

4. The system of claim **1**, further comprising the first pedicle fastener, wherein the distal end of the first passageway device is connected to the first pedicle fastener by a frangible portion configured to fracture so as to permit the first passageway device to be removed from the first pedicle fastener.

5. The system of claim **4**, wherein the frangible portion comprises a necked-down region designed to fracture in response to application of a certain pre-established linear force or angular moment.

6. The system of claim **4**, wherein the first pedicle fastener includes a pedicle screw having a cage connected thereto, the cage being configured to receive at least a portion of the one or more implants, and wherein the first passageway device is formed as a single piece with the cage of the first pedicle fastener.

7. The system of claim **1**, wherein the first passageway device comprises:

a first blade; and

a second blade discrete from the first blade;

wherein the first and second blades are positionable substantially parallel to each other to provide the first passageway device.

8. The system of claim **7**, further comprising an abutment member encircling at least a portion of the first passageway device to abut an exterior skin surface of the patient, wherein the abutment member is movable along the first passageway device to define a variable subcutaneous length of the first passageway device, and wherein the abutment member is configured to restrict relative motion between the first and second blades.

9. The system of claim **1**, further comprising an abutment member encircling at least a portion of the first passageway device to abut an exterior skin surface of the patient, wherein the abutment member is movable along the first passageway device to define a variable subcutaneous length of the passageway device.

10. The system of claim **1**, further comprising a second passageway device having a distal end and a proximal end and having a central longitudinal axis extending therealong between the distal and proximal ends, the distal end of the second passageway device being configured to be positioned proximate the second anatomic point while the distal end is connected to a second pedicle fastener implantable in the second pedicle and while the proximal end extends outside the body, the second passageway device defining a second passageway adapted to receive the second extender therein in a close concentric fit, and the second passageway device defining a first slot and a second slot extending along the

central axis from the distal end to the proximal end, the first and second slots of the second passageway device being arranged to permit passage of the one or more implants therethrough along a direction transverse to the central axis of the second passageway device.

11. The system of claim **10**, further comprising:

a third extender having a distal portion and a proximal portion, the third extender being positionable in a third implanted position in which the distal portion of the third extender is positioned proximate a third anatomic point within the body and the proximal portion of the third extender is positioned outside the body, the third anatomic point being located proximate a third pedicle of a third vertebra of the spine; and

a third passageway device having a distal end and a proximal end and having a central longitudinal axis extending therealong between the distal and proximal ends, the distal end of the third passageway device being configured to be positioned proximate the third anatomic point while the distal end is connected to a third pedicle fastener implantable in the third pedicle and while the proximal end extends outside the body, the third passageway device defining a third passageway adapted to receive the third extender therein in a close concentric fit, and the third passageway device defining a first slot and a second slot extending along the central axis from the distal end to the proximal end, the first and second slots of the third passageway device being arranged to permit passage of the one or more implants therethrough along a direction transverse to the central axis of the third passageway device;

wherein the proximal portion of the third extender provides a respective third projected point outside the body when the third extender is positioned in the third implanted position, such that the one or more implants can be configured or selected based on locations of the first, second, and third projected points.

12. The system of claim **1**, wherein the distal portion of the first extender is shaped to mate with an implant interface of the first pedicle fastener, and wherein the distal portion of the second extender is shaped to mate with an implant interface of a second pedicle fastener implantable in the second pedicle.

13. The system of claim **1**, further comprising a first bridge configured to constrain an orientation of the first extender with respect to the second extender to provide a spatial transformation of the first and second anatomic points to the first and second projected points.

14. The system of claim **13**, wherein the first bridge is configured to keep the first and second extenders parallel to each other.

15. The system of claim **14**, wherein the first bridge comprises:

a first slider configured to be coupled to a shaft of the first extender such that the first slider extends substantially perpendicular to the shaft and is rotatable about and slidable along the shaft; and

a second slider configured to be coupled to a shaft of the second extender such that the second slider extends substantially perpendicular to the shaft and is rotatable about and slidable along the shaft;

wherein the first and second sliders are configured to be slidably coupled together.

16. The system of claim **13**, further comprising:

a third extender having a distal portion and a proximal portion, the third extender being positionable in a third implanted position in which the distal portion of the third extender is positioned proximate a third anatomic point within the body and the proximal portion of the third extender is positioned outside the body, the third anatomic point being located proximate a third pedicle of a third vertebra of the spine; and

a second bridge configured to constrain an orientation of the second extender with respect to the third extender such that the system provides a spatial transformation of the first, second, and third anatomic points to first, second, and third projected points.

17. The system of claim **1**, wherein each rod interface comprises a trough having a concave closed end and an opposing open end, and wherein, when the first and second extenders are positioned in the respective first and second implanted positions, the closed ends of the troughs are positioned distally of their open ends so as to receive the rod in the position extending simultaneously through the first and second projected points.

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